SUGARBEET RESEARCH

1976 REPORT

A Report to and for
the Sole Use of Cooperators

NOT FOR PUBLICATION

F O R E W O R D

SUGARBEET RESEARCH is an annual compilation of progress reports concerning incomplete research by Agricultural Research Service investigators and cooperators who are engaged in sugarbeet variety and production research. The report has been assembled by Dr. John S. McFarlane, Technical Advisor for sugarbeet breeding. The report has been reproduced at the expense of the Beet Sugar Development Foundation, and is for the sole use of the cooperators. Much of the data has not been sufficiently confirmed to justify general release and interpretations may be modified with additional experimentation. The report is not intended for publication and should not be used for cited reference nor quoted in publicity or advertising. Reproduction of any portion of the material contained herein will not be permitted without the specific consent of the contributor or contributors.

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Trade names occur in this report solely to provide specific information and do not signify endorsement by the U.S. Department of Agriculture or the Beet Sugar Development Foundation.

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SUGARBEET RESEARCH

1976 Report

Section A

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American Crystal Sugar Company
Holly Sugar Corporation
Spreckels Sugar Division
Union Sugar Division
California Beet Growers Association

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SUMMARY OF ACCOMPLISHMENTS, 1976

RESISTANCE TO VIRUS YELLOWS--Mass selection for virus yellows resistance from BYV-BWYV infected, spaced plants was continued in 1976. The third successive selection for resistance was made in three open-pollinated lines. The first selection was made in three self-fertile composites and the second cycle of selection was made in three others. Lines previously selected for yellows resistance were evaluated in various hybrid combinations in tests at Salinas, Brawley, and statewide in cooperation with the sugar company breeders. Several lines developed in the yellows resistance program are planned for release in 1977.

Recent emphasis has been on the development of yellows-resistant, monogerm, seed-bearing parents. Yellows-resistant monogerm lines would complement the presently used yellows-resistant pollinators or would allow greater use of yellows susceptible pollinators with other favorable characteristics. Eighteen monogerm lines that were previously selected for yellows resistance or derived from partially resistant sources were evaluated in 1976. All of these lines segregate for Mendelian male sterility. In 1975 the fertile plants were rogued and the male-sterile plants were topcrossed to C17. The results of the evaluation of these hybrids are summarized in Table 976. Most of these hybrids compared favorably to US H10B for performance under infected and healthy conditions. A few of the hybrids were significantly more resistant and/or productive than US H10B. In general, the lines derived from known yellows-resistant sources and selected for yellows resistance, e.g., 4797, 4796, 3770, and 4798, gave the most yellows-resistant hybrids. Those derived primarily from curly top resistant, but yellows-susceptible sources, e.g., 4794, produced the most yellows-susceptible hybrids. Even though most of these monogerm lines are still in an early stage of development, this test demonstrated that variability for yellows resistance has now been incorporated into monogerm, type-O sources. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

VIRUS YELLOWS-RESISTANT X VIRUS YELLOWS-SUSCEPTIBLE POPULATIONS (SYNTHETICS)--When yellows-resistant pollinator lines are crossed with yellows-susceptible female lines to produce hybrids, for example, C17 and 546H3 to produce US H10B, the level of yellows resistance (as measured by % loss for sugar yield) is usually intermediate. As a further indication of the transmission and inheritance of yellows resistance, the progenies of the cross between resistant C17 and susceptible SP 6822-0(B) were evaluated. These two open-pollinated lines and their F_1, F_2, F_3, BC_1P_1, and BC_1P_2 generations were tested in a BYV-BWYV inoculated-noninoculated test at Salinas in 1976. The results of this test are summarized in Table 1276.

In this test, C17 and SP 6822-0(B) had losses of 16.2 and 61.4%, respectively. The reaction to yellows of the F_1, F_2, and F_3 as measured by % sugar yield loss were not significantly different and varied from 42.6 to 45.6%. The loss of the BC to C17 was 30.2% and was significantly more susceptible than C17 but significantly more resistant than the F_1, F_2, or F_3 generations. The values for the BC to SP 6822-0(B) did not fit as expected, but the deviation was probably due to one plot not being inoculated. These loss

values would support previous observations that yellows resistance is primarily due to additive effects. However, some deviation from the mid-parent value toward increased susceptibility was expressed by the F_1, F_2, and F_3 generations. In general, if the yellows resistance of two of the three components of two parents and their F_1 are known, the resistance of the third component should be predictable.

A somewhat surprising observation is the amount of heterosis expressed by the F_1 for beet yield and sugar yield in the noninoculated treatment. The sugar yield of the F_1 showed a significant increase of about 20% over the midparent value. The F_2 showed only about half this increase which is what is expected for the increase of a synthetic variety with two lines. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

HALF-SIB SELECTION FOR YELLOWS RESISTANCE--Two self-fertile, composite populations designated 773 and 791 were used to evaluate the use of half-sib selection for concurrently increasing virus yellows resistance and yield. Half-sib families (seed from O.P. Mendelian male sterile plants) were grown in replicated field trials and inoculated with BYV-BWYV. On the basis of yield performance, remnant seed from the selected families was recombined. To determine if this testing procedure was effective in identifying divergent genotypes, selections were made for high and low sugar yield and high and low sucrose concentration. The same source composites were also mass selected for yellows resistance using sugar yield as the criterion of selection. The results of the first cycle of selection for the populations per se and as hybrids with 546H3 have been presented in the 1974 (pages A2, A11-12, and A31) and 1975 (pages A3, A30) "Sugarbeet Research" reports.

In 1975, the unselected (C0) and selected (C1) populations of 773 and 791 were topcrossed to C17. The Mendelian male sterile segregates were used as the female plants. These hybrids were evaluated in BYV-BWYV inoculated-noninoculated tests in 1976 (Tests 1076-1 and 1076-2). The results of the 1974-1976 tests showed that one cycle of selection was moderately effective when measured by the performance and yellows resistance of the populations per se, but was not effective when measured by the performance and yellows resistance in hybrid combinations. These tests also suggested that mass selection was as effective (or no more effective) as half-sib selection for identifying genotypes that have greater yellows resistance, performance, or combining ability.

At this time, the half-sib evaluation procedure does not appear to be an effective tool for increasing the yellows resistance of a composite population: i) too few families can economically be included in the evaluation trial, ii) the evaluation procedure is expensive, time consuming, and requires a large plot area, and iii) the difficulty of obtaining highly uniform yellows infection from plot to plot increases the experimental error. Even though mass selection is also relatively inefficient per cycle of selection, much larger numbers of genotypes can be evaluated with less expense and with fewer years between cycles. Both 773 and 791 were unselected composites prior to this cycle of half-sib selection and the frequency of genes for yellows resistance may have been too low to result in significant improvement. This type of progeny selection may prove more efficient in more advanced populations, for example, after several cycles of mass selection or in combination with mass selection in which half-sib families are derived only from the mother roots of mass selected plants. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

COMPARISON OF ONE CYCLE OF S_1, FS, TC EVALUATION AND SELECTION--Progenies from a self-fertile sugarbeet composite population were evaluated and selected on the basis of S_1, full-sib (FS), and test-cross (TC) performance. Selections for sugar yield, % sucrose, amino nitrogen (NH_2-N), sodium (Na), potassium (K), and impurity index were made on the basis of S_1, FS, and TC performance. Sugar yield and % sucrose selections also were made on the basis of FS and TC performance. Response to a 10% selection intensity was determined by direct comparison of the C0 and C1 in replicated field trials (Tests 876-1, 876-2, 876-3). Selection for sugar yield resulted in increases of about 11, 0 and 3% for the S_1, TC, and FS evaluations, respectively. Selection for % sucrose resulted in increases of about 7, 7, and 6% for the same evaluation methods. Selection on the basis of S_1 performance decreased NH_2-N, Na, and K concentrations by about 40, 34, and 20%, respectively. R. T. Lewellen, I. O. Skoyen, and J. S. McFarlane.

RESISTANCE TO ERWINIA--Breeding lines equivalent to C13 for performance and yellows resistance have been developed that are highly resistant to root rot incited by *Erwinia*. The hybrids produced with these *Erwinia* resistant lines also appear to be equivalent to US H9 type hybrids but with substantially improved rot resistance. Several of the rot resistant breeding lines are planned for increase and will probably be released in the fall of 1977. R. T. Lewellen, E. D. Whitney, and I. O. Skoyen.

INTERSPECIFIC HYBRIDIZATION STUDIES--The resistance of the wild-beet species in the Patellares section was studied. The results showed that all three species, i.e., *B. procumbens*, *B. webbiana*, and *B. patellaris*, were highly resistant, but not immune, to nematode and curly top. However, those species were susceptible to the beet western yellows virus. Gamma-rays were used to irradiate the nematode-resistant plants prior to meiosis to increase the chance of chromosomal recombination. Selection for higher transmission rate of nematode resistance was conducted for both trisomic and diploid sugarbeets. M. H. Yu.

POWDERY MILDEW RESISTANCE--A group of 12 varieties with a wide range in powdery mildew resistance was evaluated for performance with and without mildew in a March-planted test. A split-plot design was used and mildew was controlled with sulfur in one-half of each replication. Mildew infection started in mid-July and became moderately severe by mid-August. Mildew grades ranged from 1-5 based on a scale of 0 = no mildew to 9 = severe mildew (page A26). Losses in sugar yield range from 2.1% for an American Crystal hybrid to 18.5% for a susceptible triploid hybrid. Significant variety x mildew interactions occurred for sugar yield and sucrose percentage.

Varieties and breeding lines were included in a November-planted bolting resistance test and rated for mildew infection in August. Grades ranged from 3 to 8 (pages A13 and A16). Curly top resistant varieties and breeding lines again tended to be among the most susceptible entries in the trials. The results of the past 3 years showed that a wide range in resistance to mildew exists within the cultivated beet. Most lines possessing curly top and bolting resistance are susceptible to mildew and a considerable breeding effort will probably be required to incorporate resistance into high performing commercial varieties. J. S. McFarlane, R. T. Lewellen, and I. O. Skoyen.

MISCELLANEOUS VARIETY TEST--A group of 12 varieties from foreign and domestic sources were evaluated for yield, sucrose, and disease resistance. A split-plot design was used and the results were analyzed both as a randomized block and a split-plot (pages A26 and A28). Curly top, yellows, and bolting caused little to no damage. Some loss occurred from powdery mildew and *Erwinia* root rot. Varietal differences were observed in susceptibility to both powdery mildew and *Erwinia* root rot. Most of the introduced varieties were significantly superior to the California developed varieties in sucrose percentage. In the absence of curly top, yellows, and bolting, varieties developed in areas other than California tended to perform as well or better than did the local varieties. J. S. McFarlane, I. O. Skoyen, and R. T. Lewellen.

TOLERANCE TO WILTING CAUSED BY THE SUGARBEET NEMATODE--Cooperative work was continued with the Instituut voor Rationele Suikerproductie in the Netherlands in the development of breeding lines tolerant to wilting caused by the sugarbeet nematode. Identical trials were grown side-by-side on land with severe nematode infestation and on land that was fumigated with DD. The fumigation was only partially effective and a moderately high population of nematodes remained. Striking differences were observed in wilting between 880, the wilt tolerant selection, and US H10 (page A73). The wilt tolerant selection was also included in a variety test under nematode free conditions.

Under conditions of medium and heavy nematode infestation, the wilt tolerant selection outyielded the US H10 check variety by 40% and 73%, respectively. When grown in a regular variety test without nematode infestation, US H10 outyielded the selection by 20%. The wilt tolerant selection proved to be highly susceptible to *Erwinia* root rot.

Results of the past 5 years demonstrated that progress has been made in breeding for wilt tolerance. Nematode losses could be reduced through the use of tolerant varieties but under heavy infestation levels damage would continue to be high. If tolerant varieties were grown commercially, nematode populations would increase the same as with susceptible varieties. The use of tolerant varieties would need to be combined with crop rotation and/or chemical controls. J. S. McFarlane and I. O. Skoyen.

FUSARIUM STALK BLIGHT RESISTANCE--A group of 20 hybrids and inbreds were evaluated at Salem, Oregon for stalk-blight resistance in cooperation with the West Coast Beet Seed Company. Wide variability occurred in resistance and ranged from near immunity in the NB 4 inbred to almost complete susceptibility in the 564 inbred (page A74). Disease ratings of hybrids between resistant and susceptible lines were similar to those of the resistant parent. Ratings for F_2 populations from resistant x susceptible crosses more nearly approached the resistant parent. Monogerm segregates with no evidence of stalk-blight infection were selected in F_2 populations from a cross between 563 and NB 1. Seed from these selected plants was sown at Salem in September 1976 and will be evaluated in 1977. The 563 inbred was developed by crossing a monogerm line to NB 1 and then backcrossing to NB 1.

Monogerm stalk-blight resistant selections from the current backcross program are expected to resemble NB 1 in performance, disease resistance, and other characters. Our results indicate that resistance to stalk blight is dominant and relatively simply inherited. There is some evidence of a loose linkage between susceptibility and the monogerm character. J. S. McFarlane and S. C. Campbell.

YIELD COMPENSATION IN SUGARBEET INFECTED WITH CURLY TOP VIRUS--During the last 15 to 20 years more virulent strains of beet curly top virus have evolved that have the capability of damaging resistant cultivars of sugarbeet. The extent of the damage induced by these isolates in relation to the amount (percent) and time of infection and the compensating role of healthy plants in total yield have not been fully investigated. A field trial in 1976 demonstrated that significant losses in both root yield and sucrose percentage occurred when 30% or more plants became infected about four weeks after seeding. With a 66.7% infection treatment, mean root weight for healthy plants was nearly 3 lbs. greater than that of the control. Inoculations made eight weeks after seeding showed significant yield losses only with a 100% inoculation treatment (57% of the plants eventually had symptoms); however, total root yield was 92% of the control. Mean root weights for diseased plants, over all CT treatments, were only about 80% of that of the control. Observations of 1975 and 1976 tests indicate that the later curly top infection occurs the longer the incubation period before symptoms appear so that compensation for total yield by healthy plants is important any time significant infection occurs, but it is most important when infection occurs in plants six weeks old or less. I. O. Skoyen and J. E. Duffus.

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 1976

DUFFUS, JAMES E. Aphids, viruses, and the yellow plague, book chapter in Aphids as Virus Vectors, Academic Press, New York. (In press)

The yellowing virus diseases are serious hazards to stable production of sugarbeet and numerous other crops throughout the world. The general acceptance of the yellowing diseases as being induced by natural factors has plagued man since the dawn of agriculture. The losses induced by members of this group indicates that they are our most important plant viruses in relation to crop damage. Beet western yellows virus, the most widespread and economically important member of the group, is emerging as the world's most economically important virus and is analyzed in detail in regard to the virus, its epidemiology and its relationship to yellowing viruses of other crops.

DUFFUS, JAMES E. Transmission of disease agents by whiteflies (Homoptera-Aloyrodidae). In Problemas de Virus y Vectores, Sociedad Venezolana de Fitopatologia, Boletin Especial No. 4. 1976. (In press)

Some 30 or more diseases have been reported to be induced by the feeding of infectious whiteflies. These diseases occur in mostly tropical areas of the world and can cause severe economic losses on various crops. Transmission of disease agents by whiteflies was reviewed on the basis of the biology of the vectors, disease and vector handling, biology of the diseases (types of disease, properties of the agents, mechanical transmission and virus-vector relationships), and the challenges of whitefly transmitted diseases (Separation of disease complexes, serology, and control).

DUFFUS, JAMES E. and GENE M. MILBRATH. Susceptibility and immunity in soybean to beet western yellows virus. Accepted for publication in Phytopathology 67.

Thirty-five soybean cultivars either related to or with a pedigree similar to that of cultivar Wells were evaluated for susceptibility to beet western yellows virus (BWYV). Some cultivars were susceptible, some apparently were immune, and the data for others indicated either heterogeneity in, or possibly an intermediate level of, susceptibility. All of the susceptible cultivars tested in this study were derived from crosses that traced back to Mandarin, a soybean cultivar introduced from northeastern China in 1911 and to AK which was introduced to the U.S. from Manchuria in 1912. Plants infected with BWYV showed various degrees of interveinal yellowing and stunting or were symptomless in the greenhouse. The data support the hypothesis that BWYV probably is related to other yellowing viruses of legumes reported from different parts of the world.

DUFFUS, JAMES E. and IRVIN O. SKOYEN. Beet curly top virus-damage losses from new strains. The California Sugar Beet-1976. (In press)

The avoidance of infection during the early part of the growing season has long been recognized as an important factor in preventing excessive losses from beet curly top virus. Field trials on sugarbeets with new severe isolates of curly top have indicated that severe losses can occur even after more than 40% of the growing season has elapsed.

DUFFUS, JAMES E. and IRVIN O. SKOYEN. Relationship of age of plants and resistance to a severe isolate of the beet curly top virus. Accepted for publication in Phytopathology 67.

Strains of the curly top virus capable of causing appreciable damage to resistant cultivars of sugarbeet are found throughout the western United States. However, little knowledge of the extent of the damage induced by these isolates was known. Field trials on sugarbeets have indicated that current strains of the curly top virus caused serious losses, even when inoculated as late as 10 wk after seeding or after more than 40% of the growing period had elapsed. Both root yield and sucrose content were significantly reduced. Disease resistance appears to be associated with differences in incubation period rather than differences in the abilities of resistant cultivars to recover from the effects of virus infection.

HILLS, F. J., D. H. HALL, L. D. LEACH, C. A. FRATE, R. T. LEWELLEN and L. CHIARAPPA. Powdery mildew of sugar beet--here to stay? Calif. Agric. 30: 16-18. 1976.

Powdery mildew, a widespread disease of sugarbeets in western U.S. since 1974, reduced sugar yields 20 to 30% in field tests. Early applications of sulfur are recommended to control the disease. Other fungicides were also tested that improved sugar production over the untreated control. The yield loss of a moderately resistant variety without chemical disease control was less than half of that of the currently used cultivar.

MAGYAROSY, A. C. and J. E. DUFFUS. Feeding preference and reproduction of the beet leafhopper on two Russian thistle plant species. J. Am. Soc. Sugar Beet Technol. 19: 16-18. 1976.

The host plant selection and reproduction of the beet leafhopper (*Circulifer tenellus*), vector of the curly top agent, was investigated on two epidemiologically important Russian thistle species. *Salsola iberica* (tumbleweed) is the preferred feeding host of the beet leafhopper. No difference was detected between *S. iberica* (tumbleweed) and *S. paulsenii* (barb-wire thistle) as far as the reproduction of the beet leafhopper is concerned.

MCFARLANE, J. S., I. O. SKOYEN and R. T. LEWELLEN. Registration of sugarbeet parental lines combining resistance to bolting and curly top. Accepted for publication in Crop Sci.

The three parental lines C563, C563 CMS, and C551 are described.

MCFARLANE, J. S., I. O. SKOYEN and R. T. LEWELLEN. Registration of sugarbeet germplasm combining resistance to bolting and curly top. Accepted for publication in Crop Sci.

The eight breeding lines C85, C85 CMS, C321, C17T, C522, C522 CMS, C536, and C536 CMS are described.

STEELE, A. E. Effects of selected carbamate and organophosphate nematicides on hatching and emergence of Heterodera schachtii. Accepted for publication in J. Nematol.

Ethoprop, oxamyl, PP 156, fenamiphos, carbofuran, AC 64,475, Bunema M®, CG 12223, aldicarb, aldicarb sulfoxide and aldicarb sulfone were tested for their effects on hatching and emergence of larvae from cysts of Heterodera schachtii. The oxime carbamates and carbofuran inhibited hatching, but this response was reversed by removing the chemical treatment. Inhibition of hatching by Bunema M® and all organophosphates tested was irreversible.

STEELE, A. E. Effects of selected carbamate and organophosphate nematicides on hatching of Heterodera schachtii. J. Nematol. 8: 303. 1976.

Aqueous solutions of ethoprop, oxamyl, phenamiphos, carbofuran, Bunema[R] (potassium N-hydroxymethyl-N-methyldithiocarbamate), and AC 64,475 [2-(diethoxyphosphinylimino)-1,3-dithietane] were tested for their effects on hatching of Heterodera schachtii. Concentrations tested ranged from 0.1 µg/ml to 1,000 µg/ml, depending on the material. Four or five replicates of 20 cysts each were treated for 1 week with the chemical solutions, then for 4 days in tap water, and then placed in sugarbeet root diffusate for 4 weeks to evaluate the residual effects on hatching. All treatments with chemical solutions inhibited hatching. However, permanent suppression of hatching was only obtained with 100 µg/ml phenamiphos or 50 µg/ml AC 64,475. All other materials only temporarily suppressed hatching. Treatments of 50 µg/ml or greater of carbofuran completely suppressed hatching (but the effect was only temporary), whereas concentrations of 0.1 µg/ml carbofuran stimulated hatching.

STEINKAMP, M. P. and L. L. HOEFERT. Annulate lamellae in phloem cells of virus-infected Sonchus plants. Accepted for publication in J. Cell Biology.

The occurrence of annulate lamellae (AL) in differentiating phloem of Sonchus oleracous (Compositae) singly infected with sowthistle yellow vein virus (SYVV) and doubly infected with a combination of SYVV and beet yellow stunt virus is documented by electron microscopy. Cell types in which AL were found were immature sieve elements and phloem parenchyma cells. AL were found only in cells that also contained SYVV particles although a direct association between the virus and AL was not apparent. Substructure of the AL and their relationships to the nuclear envelope and endoplasmic reticulum are similar to other descriptions of this organelle in the literature. This appears to be the first report of the association of AL with a plant virus disease.

WHITNEY, E. D. and R. T. LEWELLEN. Bacterial vascular necrosis and rot of sugarbeet: Effect on cultivars and quality. Accepted for publication in Phytopathology 67.

An epiphytotic caused by an Erwinia sp. on sugarbeet in the San Joaquin Valley of California was due in part to a greater susceptibility of newly introduced hybrid cultivars. The greater susceptibility of the hybrid cultivars resulted predominantly from the use of highly susceptible pollen

parents, but also was influenced by the F_1 moderately susceptible seed parent. The Erwinia-susceptible pollen parents were selected for virus yellows resistance from a moderately Erwinia-resistant parent. This suggested that an association might exist between yellows resistance and bacterial rot susceptibility. Our results did not support this hypothesis. All cultivars tested were susceptible to some degree to bacterial rot but there was variability among selections, suggesting that the pathogen probably has been present for many years in soil and became obvious after the introduction of more susceptible cultivars. A disease index (mean percentage of rot per beet) was found to be a reliable means of estimating cultivar susceptibility.

Published Papers Abstracted in Sugarbeet Research, 1975 Report

DUFFUS, JAMES E. Effects of beet western yellows virus on crambe. Plant Dis. Reptr. 59: 886-888. 1975.

LEWELLEN, R. T. and E. D. WHITNEY. Inheritance of resistance to race C2 of Cercospora beticola in sugarbeet. Crop Sci. 16: 558-561. 1976.

MACDONALD, J. D., L. D. LEACH, and J. S. MCFARLANE. Susceptibility of sugarbeet lines to the stalk blight pathogen Fusarium oxysporum f. sp. betae. Plant Dis. Reptr. 60: 192-196. 1976.

STEELE, A. E. Effects of oxime carbamate nematicides on development of Heterodera schachtii on sugarbeet. J. Nematol. 8: 137-141. 1976.

STEELE, A. E. Improved methods of hatching Heterodera schachtii larvae for screening chemicals. J. Nematol. 8: 23-25. 1976.

WHITNEY, E. D. and R. T. LEWELLEN. Identification and distribution of races C1 and C2 of Cercospora beticola from sugarbeet. Phytopathology 66: 1158-1160. 1976.

BOLTING AND VARIETY TRIALS, SALINAS, CALIFORNIA, 1975-76

Location: USDA Agricultural Research Station

Soil type: Sandy loam (Chualar series).

Previous crops: Fallow, 1975 and 1974; barley, 1973; sugarbeet trials, 1972.

Fertilizer used: Preplant: Dolomite (equivalent to 105% $CaCO_3$), as needed, was broadcast at a rate of 1150 lbs/A and disced in about 6 inches deep. All test areas had 320 lbs/A 5:20:10 applied broadcast and chiseled in before listing in October 1975. Prior to seeding, 400 lbs/A ammonium sulfate was Bye Hoe incorporated into a 9 inch band on the beds.

Supplemental nitrogen: Two applications, as sidedressed ammonium sulfate at rate of 410 lbs/A, or 20% liquid N through sprinkler irrigation system at a rate of 445 lbs/A.

Total fertilization (lbs/A):	N	P_2O_5	K_2O
	275	64	32

Summary: 1975-1976 Tests in the Salinas Valley

Test No.	Sowing Date 1975-1976	Thinning Date 1976	Test Entries No.	Reps No.	Plot Rows No.	Plot Row Lgth. Ft.	Harvest Date 1976	Test Design
176	11/12	1/20-28	96	2	1	32	--	--
276-1	"	"	64	2	1	32	--	--
276-2	"	"	56	2	1	32	--	--
276-3	"	"	40	2	1	32	--	--
276-4	"	"	64	2	1	32	--	--
376	11/13	"	23	-	1	32	--	--
476	"	"	76	4	1	32	--	RCB
576	"	"	16	4	2	32	9/7-9	RCB
676	1/7	3/12	10	10	2	53	"	Latin sq.
776	"	"	26	8	2	32	9/13-15	RCB
876-1	2/3-4	3/18-21	16	8	2	30	9/15-16	RCB
876-2	"	"	16	8	2	30	9/20-21	RCB
876-3	"	"	16	8	2	30	9/21-23	RCB
976	2/12	3/24-28	20	6	1	41	9/27-Rain 10/7-8	Split-plot
1076-1	2/11	"	7	6	1	41	9/23	Split-plot
1076-2	"	"	9	6	1	41	9/27	Split-plot
1176-1	"	"	12	6	1	41	10/12	Split-plot
1176-2	"	"	12	6	1	41	10/13	Split-plot
1276	3/17	4/24-28	7	6	1	22	10/21-22	Split-block
1376	"	"	12	5	1	22	"	Split-block
1476	3/16	"	12	5	2	53	10/14-15	Split-plot
1576-1	3/17-18	"	100	4	1	24	10/18-20	10x10 lattice
1576-2	"	"	100	4	1	24	10/26-28	repeated
1676	5/6	6/10-12	144	2	1	20	10/6-7	--

Inoculation dates (1976): Tests 976 through 1176: April 23, with a combination of BYV-BWYV.

Tests 1276 and 1376: June 4, with a combination of BYV-BWYV.

Test 1676: July 29, with a suspension of Erwinia bacterium.

Irrigation: By either furrow or sprinkler system as required at 7-14 day intervals except during stand establishment when frequent light irrigations were used.

Diseases and insects: Natural virus yellows infection was light throughout 1976, probably as a result of the aphid control provided by applications of Temik 10G. Twenty lbs/A was applied to Tests 176 through 576 on April 13 and to Tests 676 through 1176 on April 14, 1976. Temik 10G was applied to Tests 1276 through 1576 May 19, 1976.

Powdery mildew was moderately severe in 1976 where it was not controlled and occurred first in the earliest seeded tests. Spray applications of sulfur at 10-11 lbs/A between mid-July and mid-August provided good control of powdery mildew infection.

Sugar analysis: Determined from one or two samples per plot of approximately 10 roots each at the sugar analytical laboratory, U.S. Agricultural Research Station, Salinas, California.

Remarks: The assistance of Dr. F. J. Hills and Ms. Patricia Thomas, University of California at Davis, in the analysis of test data is gratefully acknowledged.

BOLTING RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1975-76
TEST 176

2 replications
1 row plots, 32 ft. long

Planted: November 12, 1975

Variety	Description	Bolting 7/20 %	Bolting 8/31 %	Powdery Mildew 8/3 Grade 1/
517H12	546H4 x 417	0.0	0.0	7.0
517H36	3536-97H23 x 417	0.0	1.0	7.0
4547H1	502H0 x 547	1.2	1.2	6.0
517TH36	3536-97H23 x 117T	1.0	2.0	7.0
517T	Inc. 117T	3.3	3.3	6.5
517TH29	3536-97H72 x 117T	3.1	4.1	6.5
517H29	3536-97H72 x 417	2.0	4.8	7.0
417H21	536-97H0 x C17	5.1	5.1	7.0
417H28	536-97H3 x C17	3.0	5.1	7.0
5103Aa	431aaMm S. st. x 417	4.2	5.2	7.0
517H8	546H3 x 417	4.2	6.2	7.0
4554H4	3565H0 x 2554 (Iso.)	4.5	6.6	5.5
585	Type O S. st.	5.9	7.1	6.0
517H17	8551H4 x 417	4.8	7.6	7.0
534	Inc. (aamm S. st. x 813)	6.6	7.8	6.5
517TH12	546H4 x 117T	7.0	8.0	7.0
434T	Tetra of Netherlands 234	4.1	8.1	5.5
Y003	Yellows resistant line	7.3	8.2	6.0
464H2	US H6	5.2	8.3	7.0
3536-97H3	562H0 x 536-97	6.7	8.6	7.5
3536-97H72	718H0 x 536-97	9.4	9.4	7.0
5551H21	3536-97H0 x 8551	6.6	9.5	7.0
5564H1	(502H0 x 562) x 564	8.1	10.3	7.0
5106Aa	2502aa x 4564C1	6.4	10.7	8.0
517TH17	8551H4 x 117T	2.6	11.2	7.0
Vytomo	Swedish variety	11.9	12.9	5.0
4554H1	NB 1 x NB 4	7.6	15.2	5.5
F71-17	Inc. F70-17	6.9	15.3	7.5
464H8	US H7A	8.8	15.7	6.5
5551H17	8551H4 x 8551	13.0	16.0	6.5
5101Aa	4136aa x 417	14.9	16.9	7.0
Y004	YRS (413 x 234)	12.6	17.5	6.5
5536-97RH22	1522-25H0 x 4536-97R	14.5	17.5	7.0
464	Pollinator line	7.8	17.6	6.0
F66-546H3	562H0 x 546	18.2	18.2	7.0
3522-25H85	536H61 x 522-25	18.1	23.4	7.5
921	Composite of Type O's	18.8	23.5	6.5
F70-413	Inc. F66-13	13.6	24.3	7.0

BOLTING RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1975-76 cont.
TEST 176

2 replications
1 row plots, 32 ft. long

Planted: November 12, 1975

Variety	Description	Bolting 7/20 %	Bolting 8/31 %	Powdery Mildew 8/3 Grade[1/]
5551H5	564H0 x 8551	23.5	27.5	7.0
915	US 15	27.1	30.1	6.0
Bush Mono	Bush-Johnson variety	22.9	31.1	5.5
2522-29H23	522-25H0 x 522-29	28.9	31.3	7.5
F63-569H3	562H0 x 569	34.1	37.7	7.5
5522-29H21	3536-97H0 x 4522-29	35.6	39.8	7.5
959	US 56	37.2	40.5	6.0
Dep 1	Line from Deprez	43.3	59.4	6.0
5942	Inc. RW 880	60.0	66.6	6.0
FC 11	731098H	46.5	75.5	5.0
AC 10	American Crystal hybrid	74.0	77.0	3.0
5937	Inc. Ramonsk 06	65.3	78.3	6.5
5939	Inc. Ramonsk 023	68.3	79.5	5.5
FC 3	69-9440	82.0	86.6	4.5
5938	Inc. Ramonsk 09	86.7	86.7	5.5
R653	Uladovsk 20mm	87.2	87.2	5.0
5941 Iso.	Inc. Yaltushkovsk mm	87.4	87.4	4.0
FC 12	731099H	86.5	90.0	5.0
GW D2	Com. hybrid	92.3	92.3	6.0
AC 5	American Crystal hybrid	95.1	96.1	4.5
UI 8	Com. hybrid	95.3	96.2	8.0
5941 RS	Inc. Yaltushkovsk mm	96.6	97.6	4.0
Yugo 89	4n line	96.0	98.1	3.0
Am 7	Amalgamated variety	100.0	100.0	8.0
5967	_Beta maritima_ (comp. Denmark)	33.3	100.0	6.0
5968	_Beta maritima_ (from Beltsville)	100.0	100.0	6.5
Coons 1	_B. vulgaris_ x _B. maritima_	55.4	100.0	6.0
Coons 2	_B. vulgaris_ x _B. maritima_	58.2	100.0	7.0
Inbred				
2512	NB 6	0.0	0.0	6.5
2547	NB 5	0.0	1.1	4.0
2554 Iso.	NB 4	0.0	1.3	4.5
4536-97	CTR inbred	4.6	4.6	5.5
5551	Inc. 8551 (Iso.)	6.1	6.1	5.5
3522-25	CTR inbred	5.5	8.7	7.0
5504	Inc. (2561aa x 3536-97)	8.0	9.0	6.0
5505C2	S_1(2563aa x 1502 Iso.)	9.0	11.3	7.0

BOLTING RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1975-76 cont.
TEST 176

2 replications
1 row plots, 32 ft. long

Planted: November 12, 1975

Variety	Description	Bolting 7/20 %	Bolting 8/31 %	Powdery Mildew 8/3 Grade[1]
4554	NB 4	8.9	12.7	4.5
5522-29HO	4522-25HO x 4522-29	12.7	14.8	7.0
5506C2	S_1(2502aa x 1565)	15.5	17.6	7.0
5536-97R	Inc. 4536-97R	12.8	18.1	7.0
4536-97HO	CMS of 536-97	16.1	18.4	7.0
3522-25HO	1522-25HO x 1522-25	12.4	19.2	7.0
4522-29	CTR inbred	18.1	21.1	7.0
F63-546	mm inbred	24.6	24.6	6.0
5522-29	Inc. 4522-29	26.0	26.0	7.0
3592	Inc. 4592	26.1	30.3	7.5
3565HO	564HO x 1565	29.6	31.6	7.0
5564HO	4564HO x 4564C1	24.3	32.1	7.0
F66-562	mm inbred	31.5	33.7	7.0
5564Aa	4564aa x 4564C1	25.7	34.2	6.5
5536-97RHO	3536-97HO x 4536-97R	32.3	35.5	7.0
F66-562HO	CMS of 562	38.9	41.1	7.0
F64-550	mm inbred	33.6	41.9	6.0
5564	Inc. 4564C1	36.6	43.1	7.0
3565	Inc. 1565	40.5	44.6	7.0
F66-569	mm inbred	40.2	46.0	7.0
F66-563HO	CMS of 563	49.7	55.6	7.0
4539	NB 8	50.8	55.7	8.0
1502 Sp.	NB 1	50.9	61.8	8.0
3511	NB 2	73.6	74.5	7.5
Mean		55.61	62.98	--
LSD (.05)		12.98	14.52	--
Coefficient of Variation (%)		11.75	11.61	--
F value		39.71**	33.11**	--

** Exceeds the 1% point of significance (F = 1.59).

1/ 0 = No mildew   9 = Severe mildew

TEST 276. BOLTING AND POWDERY MILDEW RESISTANCE
EVALUATION TEST, SALINAS, CALIFORNIA, 1976

2 replications
1-row plots, 32 ft. long

Planted: November 12, 1975

Variety	Description	Source[1/]	Bolting 7/20 %	Bolting 8/31 %	Powdery Mildew 8/9 Score[2/]
464H8	F70-546H3 x F66-64	Spence	6.6	7.6	7.0
US H10B	Lot 1068	Oregon	5.7	6.6	7.0
517H8	F70-546H3 x 417	Spence	11.0	14.1	7.5
517H29	(C718H0 x C536) x 417	Spence	1.1	4.4	7.5
517H31	(C562H0 x C718) x 417	Spence	4.0	8.0	7.5
517H33	(C718H0 x C546) x 417	Spence	8.0	11.0	7.0
523-5H8	F70-546H3 x 417-1	Spence	5.3	8.4	7.0
523-5H12	F69-546H4 x 417-1	Spence	4.8	8.7	7.0
523-5H31	(C562H0 x C718) x 417-1	Spence	10.0	10.0	8.0
523-5H33	(C718H0 x C546) x 417-1	Spence	6.3	7.4	8.0
5717H8	F70-546H3 x 4232	Spence	50.5	55.0	7.5
Y517H8	F70-546H3 x Y417	Spence	10.0	11.1	7.0
E502H8	F70-546H3 x E402	Isolator	3.1	4.1	8.0
E506H8	F70-546H3 x E406	Spence	13.6	13.6	8.0
E534H8	F70-546H3 x E434	Isolator	3.2	3.2	8.0
E536H8	F70-546H3 x E402,5,6,34	Spence	10.6	15.7	7.5
E537H8	F70-546H3 x ERS 813	Isolator	5.0	8.9	7.5
E538H8	F70-546H3 x ERS 413C	Isolator	5.8	6.8	8.0
E539H8	F70-546H3 x ERS 013A	Isolator	3.1	5.2	7.5
S-435H	Hybrid	Spreckels	8.4	11.5	8.0
S-445H	Hybrid	Spreckels	0.0	0.0	7.0
S-101H	Hybrid	Spreckels	7.7	7.7	8.0
517HL1	4740H2B x 417	Spence	16.1	25.1	7.5
517HL2	4741H2 x 417	Spence	8.4	15.7	7.5
517HL3	4789H2B x 417	Spence	16.2	22.1	7.5
517HL4	4790H2B x 417	Spence	3.9	9.7	7.5
517HL5	3791H80 x 417	Spence	12.0	16.1	7.5
517HL6	4796H72 x 417	Spence	9.4	12.6	7.5
517HL8	3773aa x 417	Spence	14.2	20.9	7.5
517HL11	3773Daa x 417	Spence	4.2	5.4	8.0
517HL14	4791aa x 417	Spence	3.8	13.7	7.5
517HL15	4791Baa x 417	Spence	16.3	21.4	8.0
517HL17	4791Daa x 417	Spence	19.3	26.8	7.0
517HL19	3770aa x 417	Spence	21.1	26.0	6.0
517HL20	3771aa x 417	Spence	25.2	34.3	6.5
517HL21	3774aa x 417	Spence	7.4	9.5	8.0
517HL22	4775Baa x 417	Spence	6.0	8.0	7.5
517HL23	4776Baa x 417	Spence	15.4	19.3	7.5
517HL24	4777Baa x 417	Spence	7.3	13.5	7.5
517HL25	4775aa x 417	Spence	9.6	15.4	7.0

TEST 276. BOLTING AND POWDERY MILDEW RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1976 cont.

Variety	Description	Source[1/]	Bolting 7/20	Bolting 8/31	Powdery Mildew 8/9
			%	%	Score[2/]
517HL26	4776aa x 417	Spence	18.0	22.8	8.0
517HL27	4777aa x 417	Spence	12.2	16.3	7.5
517HL28	4755aa x 417	Spence	14.3	28.6	6.5
517HL29	4792aa x 417	Spence	5.1	6.1	8.0
517HL30	4793aa x 417	Spence	11.9	14.9	8.0
517HL31	4794aa x 417	Spence	9.3	13.6	8.0
517HL32	4795aa x 417	Spence	16.3	22.0	8.0
517HL33	4797aa x 417	Spence	29.3	38.0	7.5
517HL34	4798aa x 417	Spence	13.1	14.1	7.5
Y501H8	F70-546H3 x Y401A	Spence	21.8	23.7	7.5
Y501H29	(C718H0 x C536) x Y401A	Spence	15.0	22.7	7.0
Y501H31	(C562H0 x C718) x Y401A	Spence	13.6	21.9	7.5
Y501H33	(C718H0 x C546) x Y401A	Spence	17.3	26.4	6.5
Y501HL3	4789H2B x Y401A	Spence	27.5	38.8	7.0
Y501HL4	4790H2B x Y401A	Spence	13.6	15.4	7.5
Y501HL5	3791H80 x Y401A	Spence	15.6	24.5	7.0
Y501HL6	4796H72 x Y401A	Spence	23.5	32.5	7.0
Y501HL35	Y417H72 x Y401A	Spence	12.5	22.7	7.0
Y522H8	F70-546H3 x Y422	Spence	8.2	13.4	8.0
Y522H29	(C718H0 x C536) x Y422	Spence	5.2	6.3	8.0
Y523H8	F70-546H3 x Y423	Spence	6.2	8.2	6.5
Y526H8	F70-546H3 x Y426	Spence	22.5	23.4	7.0
Y417H3	F66-562H0 x Y317	Spence	5.8	10.0	8.0
Y417H72	C718H0 x Y317	Spence	8.3	14.6	7.0
417	Inc. 713A (C17)	Oregon	4.0	10.0	6.0
517	Inc. 417	Spence	12.6	19.5	6.5
417-1	BRS 813	Isolator	3.2	3.2	6.5
523-5	Inc. 417-1	Isolator	3.0	4.9	6.5
523-5	Inc. 417-1	Spence	4.1	6.1	7.0
Y517	Inc. Y417	Isolator	4.9	6.9	6.0
Y517H0	Y417H0 x Y417	Isolator	8.5	16.1	6.0
Y517	Inc. Y417	Spence	11.4	18.9	6.0
Y517H0	Y417H0 x Y417	Spence	18.7	23.0	7.5
Y417	Inc. Y317	Spence	15.5	20.7	7.0
Y417H0	Y317H2 x Y317	Spence	10.9	14.0	6.5
5201	813 x 3232	G.H.	2.1	2.1	6.0
5202	Inc. 3213	Isolator	31.1	35.2	6.5
Y402	Inc. 2216	Spence	19.4	29.6	6.5
4254B	BMRS 3213B-	Isolator	74.9	76.9	6.5
4255B	BMSS 3214B-	Isolator	59.2	67.2	6.5

TEST 276. BOLTING AND POWDERY MILDEW RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1976 cont.

Variety	Description	Source[1/]	Bolting 7/20 %	Bolting 8/31 %	Powdery Mildew 8/9 Score[2/]
4272	3257 interse	Res. Sta.	13.4	18.7	6.5
F70-13	Inc. F66-413	Oregon	21.3	31.5	7.0
E502	Inc. E402	Isolator	9.8	14.7	7.5
E506	Inc. E406	Isolator	11.6	16.9	7.0
E506	Inc. E406	Spence	30.4	35.6	7.5
E534	Inc. E434	Isolator	6.4	7.6	7.0
E536	Inc. E402,5,6,34 (C36)	Isolator	13.5	13.5	6.5
E536	Inc. E402,5,6,34 (C36)	Spence	21.8	27.4	7.0
E537	ERS 813	Isolator	7.6	7.6	6.5
E538	ERS 813	Isolator	7.1	12.1	6.5
E539	ERS 013A	Isolator	12.8	18.3	6.5
Y501	Inc. Y401A (C01)	Spence	24.9	36.6	6.5
Y401A	YRS Y201	Isolator	27.7	39.4	6.0
Y331	Inc. Y231 (C31)	Spence	13.6	14.6	5.0
4247	BMRS 3209	Isolator	47.6	54.7	6.5
4276	3261 interse	Res. Sta.	36.9	46.3	7.0
Y522	Inc. Y422 (C22)	Spence	13.7	18.9	7.5
Y422	YRS Y222A	Isolator	20.1	26.1	7.0
Y333	Inc. Y233	Spence	10.1	16.2	7.5
4249	BMRS 3211	Isolator	45.9	53.6	6.5
4273	3258 interse	Res. Sta.	11.9	18.8	7.0
Y518H0	Y418H0 x Y318	Isolator	11.4	16.2	5.0
Y519H0	Y419H0 x Y319	Isolator	3.6	4.7	5.5
Y520H0	Y420H0 x Y320	Isolator	2.8	3.8	5.0
4256	BMRS 3215	Isolator	21.0	25.0	7.0
4258	BMRS 3217	Isolator	30.2	34.4	5.5
Y421	Inc. 2217	Spence	47.5	57.3	6.5
Y405	LSRS Y234,5,6,7,8	Isolator	80.7	84.5	6.0
Y523	Inc. Y423	Spence	28.3	39.7	5.5
Y526	Inc. Y426	Spence	51.3	64.1	6.5
Y416	YRS Y116	Isolator	77.4	78.4	5.0
Y430	YRS Y230A,B	Isolator	28.0	32.6	8.0
Y439	Inc. Y339	Spence	33.7	41.7	6.0
Y440	Inc. 3254	Spence	4.5	6.8	6.0
Y441	Inc. 3255	Spence	24.2	29.3	6.5
Y442	Inc. 3256	Spence	24.2	31.2	8.0
3204	Inc. Acc. 125 (Cleij)	Isolator	91.2	91.2	7.0
3205	Inc. Acc. 127 (Cleij)	Isolator	82.7	85.7	6.0
3206	Inc. Acc. 128 (Cleij)	Isolator	36.3	44.3	6.5
3207	Inc. Acc. 129 (Cleij)	Isolator	12.5	20.6	5.5

TEST 276. BOLTING AND POWDERY MILDEW RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1976 cont.

Variety	Description	Source[1/]	Bolting 7/20	Bolting 8/31	Powdery Mildew 8/9
			%	%	Score[2/]
4789	3789aa x A	Spence	21.7	22.7	7.0
4790	3790aa x A	Spence	12.1	12.1	6.5
5740	4740aa x A	Spence	18.0	32.1	7.0
5740H0	4740H2B x 4740	Spence	18.3	24.5	7.0
5741	4741aa x A	Spence	18.2	31.3	8.0
5741H0	4741H2 x 4741	Spence	11.9	17.1	6.5
5742	3791(T-O)C1aa x A	Spence	20.5	26.6	7.0
5742H2	3791H80 x 3791(T-O)C1	Spence	16.5	25.3	7.0
5742H3	F66-562H0 x 3791(T-O)C1	Spence	15.3	20.0	7.0
5742H72	C718H0 x 3791(T-O)C1	Spence	12.4	19.2	7.0
5743	3791C1aa x A	Spence	14.5	18.5	7.5
5744	YRS 3789aa x A	Isolator	19.1	20.1	7.5
5744H0	4789H2B x YRS 3789	Isolator	17.2	22.3	7.0
5745	YRS 3790aa x A	Isolator	10.6	14.8	7.0
5745H0	4790H2B x YRS 3790	Isolator	20.3	23.4	7.5
5755	4755Baa x A	Spence	35.4	38.6	7.0
5755H2	4755H72 x 4755B	Spence	33.7	39.3	6.5
5755B	YRS 3755aa x A	Isolator	17.7	29.4	5.5
5755BH2	4755H72 x YRS 3755	Isolator	25.8	28.7	6.5
5756	4755aa x YR,MM,S^f	Spence	27.4	32.3	6.0
4791	2791a-HGSaa x A	Spence	20.7	26.5	7.0
4791D	2791a-HSaa x A	Spence	16.3	17.4	7.5
5791B	4791Baa x A	Spence	14.7	23.0	7.5
5791F	3791-HGS(S_1)aa x A	Spence	10.8	11.7	6.5
5791G	3791-HGS(TC)aa x A	Spence	35.8	39.0	6.5
5791H	3791-HGS(Sib)aa x A	Spence	30.1	40.1	7.0
5791I	3791-HS(S_1)aa x A	Spence	9.0	17.0	7.0
5791J	3791-HS(TC)aa x A	Spence	23.7	28.7	7.5
5791K	3791-HS(Sib)aa x A	Spence	25.0	36.0	6.5
5791P	3791-LPM(S_1,Sib)aa x A	Spence	18.2	21.5	5.5
5742H8	F70-546H3 x 3791(T-O)C1	Spence	23.9	27.7	7.0
5743H8	F70-546H3 x 3791C1	Spence	8.6	10.6	7.0
5791FH8	F70-546H3 x 3791-HGS(S_1)	Spence	6.6	10.3	7.0
5791IH8	F70-546H3 x 3791-HS(S_1)	Spence	2.8	6.6	7.0
5791PH8	F70-546H3 x 3791-LPM(S_1,Sib)	Spence	17.4	20.3	6.5
5742H37	Y417H0 x 3791(T-O)C1	Spence	15.1	17.8	6.0
5743H37	Y417H0 x 3791C1	Spence	11.7	14.6	7.5
5791FH37	Y417H0 x 3791-HGS(S_1)	Spence	14.0	22.0	7.0
5791IH37	Y417H0 x 3791-HS(S_1)	Spence	7.8	11.6	7.0
5791PH37	Y417H0 x 3791-LPM(S_1,Sib)	Spence	16.8	19.9	5.5

TEST 276. BOLTING AND POWDERY MILDEW RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1976 cont.

Variety	Description	Source[1/]	Bolting 7/20	Bolting 8/31	Powdery Mildew 8/9
			%	%	Score[2/]
F71-705	Inc. C0705	Oregon	33.3	35.2	6.5
F71-705HO	C0705HO x C0705	Oregon	35.2	41.6	6.5
3705	Inc. 2705 (C706)	Spence	13.9	28.7	6.5
3705HO	2705HO x 2705 (C706HO)	Spence	18.5	23.2	6.5
F74-718	Inc. C2718	Oregon	12.2	19.1	7.0
F74-718HO	C2718HO x C2718	Oregon	13.6	15.8	6.0
3718	Inc. 2718 (C718)	Spence	9.9	12.8	6.5
3718HOB	2718HO x 2718 (C718HO)	Spence	6.7	7.7	7.0
5718	Inc. 3718 (Iso.)	Isolator	3.0	5.0	8.0
5718HO	Inc. 3718HO(Iso.)x 3718(Iso.)	"	5.8	10.2	7.5
5701	Inc. 3601-5C1	Isolator	11.3	16.9	7.5
5702A	Inc. 3798-1,2,4,5,6	Isolator	3.0	6.1	7.0
5703A	Inc. 3793-5,10,11	Isolator	4.0	5.0	6.5
5778	Inc. 3778-10,17	Isolator	4.7	6.6	6.5
5779	Inc. 3779-7,16,17	Isolator	3.9	4.8	2.0
5780	Inc. 3780-4,6,7,11	Isolator	0.0	1.0	7.5
5788	Inc. 4788	Isolator	16.2	20.7	3.0
5717	Inc. 4232	Spence	64.7	73.7	7.5
5236	4232⊗	Res. Sta.	26.8	33.2	4.0
5242-1	4282-1⊗	Res. Sta.	30.5	32.5	6.5
5242-2	4282-2⊗	Res. Sta.	44.7	45.8	6.5
5242-3	4282-3⊗	Res. Sta.	20.3	24.9	6.0
5796-1	Inc. 4796-1	Isolator	8.7	9.6	7.0
5796-2	Inc. 4796-2	Isolator	9.1	13.7	7.0
5277C1	4277C1⊗	Res. Sta.	24.6	27.1	7.5
5278C1	4278C1⊗	Res. Sta.	13.9	17.4	8.0
4791C1mm	2791a-HS,HGSmm⊗	Res. Sta.	14.8	22.0	7.0
5706-1	3791-Amm⊗	Res. Sta.	12.4	14.7	7.5
5706-2	3791-amm⊗	Res. Sta.	23.7	29.0	8.0
5770	YRS 3770⊗	Res. Sta.	24.9	30.8	3.0
5771	YRS 3771⊗	Res. Sta.	33.7	38.4	6.5
5774	YRS 3774⊗	Res. Sta.	48.5	73.4	7.5
5775	4775⊗	Res. Sta.	41.4	43.6	7.0
5776	4776⊗	Res. Sta.	23.1	30.9	8.0
5792	4792A⊗	Res. Sta.	13.7	19.5	6.0
5794	4794⊗	Res. Sta.	13.4	15.3	7.5
5795	4795A⊗	Res. Sta.	7.8	11.7	7.5
5797	4797A⊗	Res. Sta.	20.0	25.6	5.5
5742A	Inc. 3791(T-O)C1	Spence	27.7	31.0	6.0
5755BA	YRS 3755	Isolator	6.3	9.2	5.5

TEST 276. BOLTING AND POWDERY MILDEW RESISTANCE EVALUATION TEST, SALINAS, CALIFORNIA, 1976 cont.

Variety	Description	Source[1/]	Bolting 7/20	Bolting 8/31	Powdery Mildew 8/9
			%	%	Score[2/]
5744A	YRS 3789	Isolator	17.6	22.8	8.0
5745A	YRS 3790	Isolator	12.3	15.2	7.5
3705H3	F66-562HO x C706	Spence	13.1	18.7	7.5
3705H72B	C718HO x C706	Spence	9.7	10.5	7.5
3546H54	C706HO x F70-546	Spence	14.1	16.1	7.5
3718H3	F66-562HO x C718	Spence	19.2	21.2	7.0
3546H72B	C718HO x F70-546	Spence	16.2	20.0	6.5
F70-546H3	562HO x F63-546	Oregon	9.1	15.0	7.0
5701H72	C718HOB x 3601-5C1	Isolator	17.8	20.5	7.0
5702H72	C718HOB x 3798-1,2,4,5,6	Isolator	9.5	12.3	8.0
5703H72	C718HOB x 3793-5,10,11	Isolator	4.0	6.9	8.5
5761-3H72	C718HOB x YRS 3761-3	Isolator	5.6	6.5	6.5
5778H72	C718HOB x 3778-10,17	Isolator	13.8	22.9	5.5
5779H72	C718HOB x 3779-7,16,17	Isolator	5.6	8.3	4.5
5780H72	C718HOB x 3780-4,6,7,11	Isolator	6.6	13.4	6.0
5788H72	C718HOB x 4788	Isolator	8.2	16.3	4.5
5233	4229⊗	Res. Sta.	4.8	6.7	7.0
5234	4230⊗	Res. Sta.	1.1	1.1	7.5
5235	4231⊗	Res. Sta.	29.0	43.6	7.0
5237	4233⊗	Res. Sta.	61.9	74.4	5.0
5238	4234⊗	Res. Sta.	100.0	100.0	---
5239	4235⊗	Res. Sta.	33.1	36.1	7.0
5240	4236⊗	Res. Sta.	20.0	22.0	3.0
5241	4237⊗	Res. Sta.	55.0	79.5	6.0

1/ Because the environment under which the seed was produced appears to affect the subsequent bolting tendency, the source of the seed is given: Spence = Spence Field increase; Isolator = greenhouse isolation chamber; G.H. = bagged plants from greenhouse; and Res. Sta. = bagged plants from field. For an equivalent increase the bolting tendency is usually: Spence ≳ Oregon > G.H. ≳ Isolator.

2/ Powdery mildew scored from 0 to 9 (0 = no mildew, 9 = severe mildew).

TEST 376. EVALUATION OF BOLTING TENDENCY OF BOLTING RESISTANT X BOLTING SUSCEPTIBLE LINES, SALINAS, CALIFORNIA, 1976

Completely random designs
1-row plots, 32 ft long

Planted: November 13, 1975

Line No.	Generation	No. plants	% Bolting 4/26	5/10	5/24	6/7	6/16	6/28	7/12	8/2	8/24
4203[a]	P_1 Inc. C17	153	0	0	0	0	1	4	6	7	8
4210[b]	B_1P_1 (C17 x SP22) x C17	129	0	0	6	13	19	34	39	44	47
5221[c]	B_1P_1 (C17 x SP22) x C17	105	0	0	5	6	13	18	23	24	24
4206[b]	F_1 (C17 x SP22)	51	0	0	10	33	39	57	59	69	69
5219[c]	F_1 (C17 x SP22)	55	0	0	4	33	53	71	73	76	78
4204[a]	F_2 Inc. (C17 x SP22)	626	0	4	19	35	46	59	65	73	76
4211[b]	B_1P_2 (C17 x SP22) x SP22	121	1	28	54	78	82	94	94	98	98
5220[c]	B_1P_2 (C17 x SP22) x SP22	102	1	5	36	68	79	86	88	93	93
4205[a]	P_2 Inc. SP22 = SP6822-0	152	4	27	57	78	85	93	95	99	99

[a] Seed produced in 1974 in greenhouse isolators.
[b] Seed produced in 1974 by pair crossing under bags in greenhouse.
[c] Seed produced in 1975 by pair crossing under bags in greenhouse.

5212	P_1 NB6 ⊗	104	0	0	0	0	0	0	0	0	0
5214CMS	B_1P_1 (760HO x NB6) x NB6	89	0	0	0	0	0	1	1	1	2
5213CMS	F_1 760HO x NB6	88	0	0	0	0	0	1	1	1	3
5215	F_2 (NB6rr x 760R)R ⊗	447	0	0	1	2	3	8	10	16	17
5215CMS	F_2 (760HO x NB6) x F_1R	473	0	0	0	1	3	4	6	12	12
5211CMS	B_1P_2 (760HO x NB6) x 760	111	0	0	3	10	19	26	30	37	40
5210CMS	P_2 CMS 760HO x 760	90	0	1	5	11	24	37	39	50	51
5210	P_2 760 ⊗	100	0	0	6	23	25	33	47	47	47

Seed produced in 1975 in greenhouse isolators.
NB6 = nonbolting, self-fertile, inbred.
760 = self-fertile, inbred.

TEST 576. BOLTING AND YIELD EVALUATION TEST, SALINAS, CALIFORNIA, 1976

4 replications
2-row plots, 32 ft. long

Planted: November 13, 1975
Harvested: September 7-9, 1976

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot	Beets/ 100'	Bolting 7/20	Bolting 8/30
		Pounds	Tons	Percent	Percent	Number	Percent	Percent
Y522H29	3536-97H72 x Y422	11,650	42.75	13.63	0.8	153	9.9	15.1
S-445H	NB Spreckels Hybrid	11,130	37.74	14.79	1.1	146	2.2	3.3
464H8	F70-546H3 x F66-64	11,020	36.87	14.95	0.3	162	10.8	16.1
517H29	3536-97H72 x 417	10,850	38.55	14.11	1.5	167	3.0	6.8
S-101H	Spreckels Hybrid	10,780	39.42	13.66	1.3	147	11.7	16.2
Y501H29	3536-97H72 x Y401A	10,760	37.95	14.19	1.0	151	18.3	28.7
517H31	3718H3 x 417	10,750	39.36	13.66	1.3	156	10.8	18.7
523-5H8	F70-546H3 x 417-1	10,640	38.67	13.75	0.8	158	8.1	14.0
E536H8	F70-546H3 x E402,5,6,34 (C36)	10,560	36.87	14.34	0.8	163	15.8	19.9
E506H8	F70-546H3 x E406-2,3,...	10,420	36.12	14.45	0.2	162	14.5	21.0
523-5H31	3718H3 x 417-1	10,310	39.24	13.15	1.6	144	11.9	17.0
Y517H29	3536-97H72 x Y417	10,190	36.72	13.91	3.7	150	10.4	15.7
5791IH37	Y417H0 x 3791-HS (S1)	10,150	36.90	13.76	0.0	148	23.3	32.3
US H10B	Lot 1068	9,840	34.74	14.20	0.7	164	13.1	18.2
S-435H	Spreckels Hybrid	9,780	34.71	14.11	0.5	161	17.9	24.3
5717H8	F70-546H3 x 4232	8,410	32.31	13.03	0.0	146	52.0	57.5
Mean		10,450	37.43	13.98	1.0	155	14.6	20.3
LSD (.05)		657	2.79	0.71	1.5	NS	6.0	6.8
Coefficient of Variation (%)		4.4	5.2	3.6	107.3	7.6	29.0	23.6
F value		9.9**	6.0**	4.4**	3.0**	NS	28.5**	25.9**

TEST 676. HYBRID TEST, SALINAS, CALIFORNIA, 1976

10 x 10 Latin Square
2-row plots, 53 ft. long

Planted: January 7, 1976
Harvested: September 7-9, 1976

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Root Rot Percent	Beets/ 100' Number	Bolting Percent
517H12	F59-546H4 x 417	10,930	39.53	13.84	2.5	129	0.1
Y501H29	3536-97H72 x Y401A	10,880	39.31	13.88	2.2	127	3.0
Y522H29	3536-97H72 x Y422	10,880	40.65	13.42	2.3	128	0.2
417H27	3565H72 x 813	10,880	40.26	13.54	2.2	126	0.4
523-5H31	3718H3 x 417-1	10,720	39.45	13.61	2.4	128	0.2
517H29	3536-97H72 x 417	10,590	39.02	13.58	3.2	134	0.2
517H17	8551H4 x 417	10,520	41.09	12.83	1.5	133	0.0
517H36	3536-97H23 x 417	10,450	38.33	13.65	2.7	135	0.0
US H10B	Lot 1068	10,320	38.27	13.50	1.4	128	1.3
Y517H29	3536-97H72 x Y417	10,180	38.30	13.33	2.4	123	0.5
Mean		10,640	39.42	13.52	2.3	129	0.6
LSD (.05)		351	1.21	0.35	NS	4.3	0.7
Coefficient of Variation (%)		3.7	3.4	2.9	64.5	3.7	131.0
F value		4.5**	5.4**	5.6**	NS	5.6**	14.8**

TEST 776. HYBRID TEST, SALINAS, CALIFORNIA, 1976

8 replications
2-row plots, 32 ft. long

Planted: January 7, 1976
Harvested: September 13-15, 1976

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot	Beets/ 100'
		Pounds	Tons	Percent	Percent	Number
Y523H8	F70-546H3 x Y423	11,880	42.78	13.89	1.0	131
464H8	F70-546H3 x F66-64	11,610	41.12	14.12	0.7	134
Y501H31	3718H3 x Y401A	11,530	41.90	13.78	3.9	130
Y501H8	F70-546H3 x Y401A	11,490	41.85	13.73	3.0	133
Y522H31	3718H3 x Y422	11,400	42.36	13.49	5.1	134
517H33	3546H72B x 417	11,370	42.35	13.46	4.3	128
517H31	3718H3 x 417	11,340	42.59	13.33	3.7	138
517H72	3718H0B x 417	11,330	42.48	13.36	5.8	133
Y501HL3	4789H2B x Y401A	11,300	40.77	13.86	2.7	128
Y522H8	F70-546H3 x Y422	11,250	41.85	13.44	3.4	128
517HL2	4741H2 x 417	11,230	40.71	13.80	4.6	131
Y526H8	F70-546H3 x Y426	11,220	39.29	14.28	1.2	130
E506H8	F70-546H3 x E406-2,3,...	11,140	40.95	13.61	1.2	133
523-5H8	F70-546H3 x 417-1	11,030	40.35	13.68	4.3	131
517H8	F70-546H3 x 417	10,870	40.06	13.57	2.7	127
5791FH37	Y417H0 x 3791-HGS (S1)	10,860	40.85	13.34	4.2	125
517HL3	4789H2B x 417	10,850	40.83	13.29	6.8	123
US H10B	Lot 1068	10,780	40.25	13.41	2.5	137
517HL8	3773aa x 417	10,750	40.49	13.28	5.2	123
517HL1	4740H2B x 417	10,720	40.47	13.27	7.6	132
Y501HL4	4790H2B x Y401A	10,720	39.54	13.56	3.6	127
517HL4	4790H2B x 417	10,690	40.83	13.10	4.0	131
5791IH37	Y417H0 x 3791-HS (S1)	10,660	40.37	13.23	4.7	127
E536H8	F70-546H3 x E402,5,6,34 (C36)	10,630	40.43	13.18	1.3	129
517HL14	4791aa x 417	9,950	38.32	13.01	3.6	129
5717H8	F70-546H3 x 4232	9,570	35.78	13.38	0.3	134
Mean		10,990	40.75	13.50	3.5	130
LSD (.05)		656	1.89	0.61	2.5	7.7
Coefficient of Variation (%)		6.1	4.7	4.6	71.6	6.0
F value		4.9**	4.8**	2.4**	4.3**	1.9**

TEST 1476. POWDERY MILDEW EVALUATION OF MISCELLANEOUS VARIETIES, SALINAS, CALIFORNIA, 1976

5 replications, split-plot
2 mildew treatments
2 row plots, 53 ft. long

Planted: March 16, 1976
Harvested: October 15, 1976

Variety	Description	Sugar Yield			Beet Yield		
		Check	Mildew	Loss	Check	Mildew	Loss
		Pounds	Pounds	Percent	Tons	Tons	Percent
S72-315	American Crystal Hybrid	11,785	11,657	2.1	40.01	38.46	4.0
517TH17	551H4 x C17 (4n)	11,750	9,576	18.5	43.85	37.64	14.2
644	Ramonsk 023 (Russian)	11,451	10,015	12.5	38.43	34.37	10.5
417H21	536-97H0 x C17	11,405	9,490	16.6	44.43	37.50	15.4
317H8	US H10B	11,386	10,191	10.1	40.92	38.04	7.1
642	Ramonsk 06 (Russian)	11,309	10,627	9.6	39.31	36.60	8.7
Vytomo	Swedish variety	11,294	9,823	12.2	38.49	35.75	7.1
643	Ramonsk 09 (Russian)	11,277	10,324	8.4	39.33	36.24	7.8
517H17	551H4 x C17	11,240	10,143	10.9	44.45	40.57	8.5
364H8	US H7A	11,185	10,382	7.2	40.81	37.74	7.4
655	Yaltushkovsk mm (Russian)	11,102	10,495	5.5	40.77	37.44	8.2
RW 880	Nematode wilt tol. sel.	9,890	8,143	17.6	36.41	31.80	12.4
Mean		11,256[a]	10,072[b]	10.9	40.60[a]	36.85[b]	9.3
LSD (.05)		813	727	8.0	2.67	2.26	NS
Coefficient of Variation (%)		5.7	5.7	57.4	5.1	4.8	61.3
F value		2.79**	10.55**	3.10**	7.35**	7.70**	1.66

Significant variety x mildew interactions occurred for sugar yield and sucrose percentage at the 1% level.
Paired means with a letter in common are not significantly different.
*Exceeds the 5% level of significance (F = 2.01).
**Exceeds the 1% level of significance (F = 2.68).

TEST 1476. POWDERY MILDEW EVALUATION OF MISCELLANEOUS VARIETIES, SALINAS, CALIFORNIA, 1976 cont.

5 replications, split-plot
2 mildew treatments
2 row plots, 53 ft. long

Planted: March 16, 1976
Harvested: October 15, 1976

Variety	Description	Sucrose			Powdery	Root Rot		Beets/100' 2/	
		Check	Mildew	Loss	Mildew	Check	Mildew	Check	Mildew
		Percent	Percent	Percent	Grade 1/	Percent	Percent	Number	Number
S72-315	American Crystal Hybrid	14.7	15.2	-2.9	1.2	0.0	0.1	146	149
517TH17	551H4 x C17 (4n)	13.4	12.7	4.9	5.0	8.2	6.8	135	138
644	Ramonsk 023 (Russian)	14.9	14.6	2.3	3.4	1.7	1.0	134	123
417H21	536-97H0 x C17	12.8	12.7	1.4	4.8	2.3	3.3	136	134
317H8	US H10B	13.9	13.4	3.7	4.8	2.4	3.1	139	137
642	Ramonsk 06 (Russian)	14.3	14.5	-1.5	3.6	1.9	1.8	138	131
Vytomo	Swedish variety	14.7	13.8	6.0	4.8	3.0	2.6	135	139
643	Ramonsk 09 (Russian)	14.4	14.3	0.5	2.6	1.2	0.6	137	139
517H17	551H4 x C17	12.6	12.5	0.8	5.0	2.3	1.9	143	142
364H8	US H7A	13.7	13.8	-0.3	3.8	0.7	0.4	137	138
655	Yaltushkovsk mm (Russian)	13.6	14.0	-3.0	2.2	0.3	0.6	136	137
RW 880	Nematode wilt tol. sel.	13.6	12.8	5.7	5.0	10.5	11.2	120	110
Mean		13.9a	13.7a	1.5	3.9	2.9a	2.8a	136a	135a
LSD (.05)		0.5	0.6	5.2	0.5	2.3	2.0	8	9
Coefficient of Variation (%)		2.6	3.4	279	10.05	63.3	55.6	4.8	5.5
F value		19.96**	17.52**	2.96**	53.41**	15.23**	22.03**	4.41**	9.12**

Significant variety x mildew interactions occurred for sugar yield and sucrose percentage at the 1% level.
Paired means with a letter in common are not significantly different.
*Exceeds the 5% level of significance (F = 2.01).
**Exceeds the 1% level of significance (F = 2.68).

1/ 0 = No mildew, 9 = Severe mildew.
2/ Yield adjustments were made for stand gaps of 2 feet or more.

TEST 1476. MISCELLANEOUS VARIETY TEST, SALINAS, CALIFORNIA, 1976

10 replications, randomized block
2 row plots, 53 ft. long

Planted: March 14, 1976
Harvested: October 15, 1976

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot	Beets/ 100'
		Pounds	Tons	Percent	Percent	Number
S72-315	American Crystal Hybrid	11,720a	39.23bc	14.9a	0.1a	148
642	Ramonsk 06 (Russian)	10,970b	37.96cd	14.4bc	1.9bcd	134
643	Ramonsk 09 (Russian)	10,800b	37.79cd	14.3bc	0.9abc	138
655	Yaltushkovsk mm (Russian)	10,800b	39.11bc	13.8de	0.4ab	137
317H8	US H10B	10,790b	39.48bc	13.7e	2.7d	138
364H8	US H7A	10,780b	39.28bc	13.7e	0.6abc	137
644	Ramonsk 023 (Russian)	10,730b	36.40d	14.7ab	1.3abcd	128
517H17	551H4 x C17	10,690b	42.51a	12.6h	2.1cd	142
517TH17	551H4 x C17 (4n)	10,660b	40.74ab	13.1fg	7.5e	137
Vytoma	Swedish variety	10,560b	37.12d	14.2cd	2.8d	137
417H21	536-97H0 x C17	10,450b	40.97ab	12.8gh	2.8d	135
RW 880	Nematode wilt tol. sel.	9,020c	34.10e	13.2f	10.8f	115
Mean		10,660	38.72	13.8	2.8	136
LSD (.05)		577	1.77	0.41	1.44	---
Coefficient of Variation (%)		6.1	5.2	3.3	57.7	---
F value		8.70**	12.65**	6.18**	38.27**	---

**Exceeds the 1% point of significance (F = 2.43).

Means with a letter in common are not significantly different at the 5% level.

TEST 976. VIRUS YELLOWS AND COMBINING ABILITY EVALUATION OF MONOGERM LINES SELECTED FOR YELLOWS RESISTANCE
SALINAS, CALIFORNIA, 1976

6 replications
2 virus treatments
1-row plots, 41 ft. long

Planted: February 12, 1976
Inoculated with BYV-BWYV: April 23, 1976
Harvested: September 27; (Rain); October 7, 1976 1/

		Sugar Yield (lbs/A)			Beet Yield (tons/A)			% Sucrose			Beets/ 100'	% Root Rot
Variety	Description	Check	Inoc.	% Loss	Check	Inoc.	% Loss	Check	Inoc.	% Loss	Number	Check
517HL28	4755aa x 417	12,110	7,620	36.7	48.54	34.69	28.3	12.46	10.97	11.9	126	6.5
517HL22	4775Baa x 417	11,990	7,640	36.4	46.55	32.27	30.7	12.87	11.85	7.7	129	1.5
517HL30	4793aa x 417	11,990	7,770	35.1	47.33	33.73	28.7	12.68	11.54	8.9	125	0.3
517HL27	4777aa x 417	11,690	8,130	30.3	47.48	35.89	24.4	12.31	11.31	8.0	128	4.3
517HL20	3771aa x 417	11,620	7,890	31.9	47.61	34.51	27.4	12.21	11.46	6.0	122	1.3
517HL5	3791H80 x 417	11,540	7,660	33.4	46.76	33.41	28.5	12.32	11.46	7.0	127	4.5
517HL29	4792aa x 417	11,530	7,740	32.5	44.36	33.77	23.8	12.99	11.45	11.7	122	6.2
517H29	3536-97H72 x 417	11,490	7,670	33.1	46.56	33.72	27.5	12.33	11.38	7.7	135	2.2
517HL33	4797aa x 417	11,440	8,460	25.8	46.91	36.67	21.7	12.19	11.52	5.4	119	3.4
517HL24	4777Baa x 417	11,340	7,400	34.5	47.97	34.66	27.5	11.82	10.70	9.5	134	1.9
517HL6	4796H72 x 417	11,210	7,770	30.5	45.31	34.41	23.8	12.36	11.31	8.5	126	4.2
517HL26	4776aa x 417	11,190	8,470	23.9	43.43	35.21	18.8	12.90	12.05	6.3	130	2.7
517HL31	4794aa x 417	11,190	6,990	37.3	46.25	30.75	33.5	12.10	11.35	5.9	119	2.4
517HL25	4775aa x 417	11,140	7,720	30.4	44.50	32.92	25.9	12.51	11.72	6.3	123	2.8
517HL32	4795aa x 417	11,080	7,450	32.7	44.18	31.16	29.4	12.54	11.95	4.7	125	4.9
517HL21	3774aa x 417	10,990	7,820	28.8	44.45	34.12	23.2	12.36	11.44	7.3	116	2.2
517HL23	4776Baa x 417	10,930	6,570	39.2	44.93	29.04	35.0	12.15	11.30	6.8	128	1.7
US H10B	546H3 x C17 (1068)	10,890	6,970	35.3	43.53	29.52	31.8	12.50	11.79	5.5	131	1.7
517HL19	3770aa x 417	10,830	8,690	19.7	45.04	38.52	14.4	12.02	11.26	6.2	130	0.6
517HL34	4798aa x 417	10,430	7,510	27.8	43.25	32.39	25.0	12.06	11.58	3.9	123	5.8
Mean		11,330	7,700	31.8	45.75	33.57	26.5	12.38	11.47	7.3	126	3.1
LSD (.05)		870	800	8.6	2.76	3.14	7.7	0.45	0.43	NS	6	3.5
Coefficient of Variation (%)		6.7	9.0	23.7	5.3	8.2	25.5	3.2	3.3	60.3	6	99.5
F value		1.9*	3.2**	2.5**	2.8**	4.2**	3.1**	3.7**	4.2**	NS	5**	2.2**

Significant variety x virus treatment interactions occurred for sugar yield and beet yield at the 0.01 level.
Means for virus treatments were significantly different for sugar yield, beet yield, % sucrose, and % rot.

1/ After harvesting four rows on September 27, further harvest was delayed until October 7 by ca. 2.5" of rain. This delay caused an average increase in tonnage of 2.18 T/A and a decrease of 1.6% sucrose. Before ANOVA, the plots harvested on September 27 were adjusted by these values.

TEST 1076-1. VIRUS YELLOWS AND COMBINING ABILITY EVALUATION OF 773 POPULATIONS WITH C17, SALINAS, CA, 1976

6 replications
2 virus treatments
1-row plots, 41 ft. long

Planted: February 11, 1976
Inoculated with BYV-BWYV: April 23, 1976
Harvested: September 23, 1976

Variety	Description[1/]	Sugar Yield (lbs/A) Check	Sugar Yield (lbs/A) Inoc.	Sugar Yield (lbs/A) % Loss	Beet Yield (tons/A) Check	Beet Yield (tons/A) Inoc.	Beet Yield (tons/A) % Loss	% Sucrose Check	% Sucrose Inoc.	% Sucrose % Loss	Beets/ 100' Number	% Root Rot Check
517HL8	(2) 3773aa x 417	11,880	8,860	25.2	43.26	35.00	18.8	13.73	12.64	7.8	123	4.2
517HL9	(3) 3773Baa x 417	11,810	8,150	30.7	43.13	33.07	23.2	13.69	12.36	9.5	129	1.9
517HL11	(5) 3773Daa x 417	11,400	8,130	28.5	41.61	33.17	20.3	13.70	12.30	10.2	130	1.3
517HL12	(6) 3773Eaa x 417	11,400	7,890	30.6	42.06	32.26	23.2	13.55	12.23	9.6	119	1.0
US H10B	Lot 1068	11,340	7,580	33.2	40.64	29.32	28.0	13.95	12.92	7.3	132	1.3
517HL7	(1) 2773aa x 417	11,130	8,580	22.3	41.55	34.57	16.6	13.38	12.43	6.9	127	1.9
517HL10	(4) 3773Caa x 417	10,960	8,760	19.3	39.76	33.98	14.0	13.78	12.88	6.2	127	4.3
Mean		11,420	8,280	27.1	41.71	33.05	20.6	13.68	12.54	8.2	127	2.3
LSD (.05)		NS	800	12.8	NS	2.66	7.5	NS	NS	NS	8	NS
Coefficient of Variation (%)		7.7	8.2	29.9	5.6	6.8	30.9	3.6	4.6	73.6	7	119.5
F value		NS	2.9*	2.3*	NS	4.2**	3.2*	NS	NS	NS	3*	NS

Means for virus treatments were significantly different for sugar yield, beet yield, and % root rot.

1/ 1 = CO: An unselected, self-fertile composite segregating A:aa. 2 = Cl Syn 1: Half-sib selection for high sugar yield under virus yellows conditions. 3 = Cl Syn 2: Mass selection for sugar yield under virus yellows conditions. 4 = Cl Syn 1: Half-sib selection for low sugar yield under virus yellows conditions. 5 = Cl Syn 1: Half-sib selection for high % sucrose under virus yellows conditions. 6 = Cl Syn 1: Half-sib selection for low % sucrose under virus yellows conditions.

TEST 1076-2. VIRUS YELLOWS AND COMBINING ABILITY EVALUATION OF 791 POPULATIONS WITH C17, SALINAS, CA, 1976

6 replications
2 virus treatments
1 row plots, 41 ft. long

Planted: February 11, 1976
Inoculated with BYV-BWYV: April 23, 1976
Harvested: September 27, 1976

		Sugar Yield (lbs/A)			Beet Yield (tons/A)			% Sucrose			Beets/ 100'	% Root Rot
Variety	Description1/	Check	Inoc.	% Loss	Check	Inoc.	% Loss	Check	Inoc.	% Loss	Number	Check
517HL16	(4) 4791Caa x 417	11,820	7,810	33.5	41.60	29.01	29.9	14.22	13.48	5.1	125	2.9
US H10B	Lot 1068	11,640	7,370	36.5	40.65	28.01	31.0	14.32	13.17	8.1	133	2.4
517HL17	(5) 4791Daa x 417	11,610	7,440	35.6	40.67	28.63	29.3	14.28	12.98	8.9	120	2.7
5791FH37	Y417HO x 3791-HGS(S_1)	11,560	7,630	33.4	41.95	30.08	28.2	13.76	12.70	7.5	131	2.8
517HL13	(1) 3791aa x 417	11,420	8,230	27.7	40.29	30.53	23.9	14.18	13.48	4.8	125	5.7
517HL14	(2) 4791aa x 417	11,240	7,810	30.1	39.50	29.39	24.9	14.25	13.30	6.6	123	6.5
517HL18	(6) 4791Eaa x 417	11,200	7,600	31.9	40.31	29.31	26.7	13.92	12.96	6.8	120	2.7
517HL15	(3) 4791Baa x 417	11,160	7,880	29.0	39.44	29.26	25.6	14.13	13.45	4.7	123	4.9
5791IH37	Y417HO x 3791-HS(S_1)	10,860	7,810	28.1	38.58	29.19	24.4	14.08	13.39	4.8	123	1.7
Mean		11,390	7,730	31.7	40.33	29.27	27.1	14.13	13.21	6.4	125	3.6
LSD (.05)		NS	NS	NS	NS	NS	NS	NS	0.44	NS	6	NS
Coefficient of Variation (%)		6.6	8.7	25.1	5.9	7.7	28.9	3.3	2.8	63.3	6	79.9
F value		NS	NS	NS	NS	NS	NS	NS	3.3**	NS	2*	NS

A significant variety x virus interaction occurred only for % root rot.

Means for virus treatments were significantly different for sugar yield, beet yield, % sucrose, and % root rot.

1/ 1 = CO: An unselected, self-fertile composite segregating A:aa. 2-6 see footnote for test 1076-1.

TEST 1176-1. VIRUS YELLOWS EVALUATION OF ERWINIA RESISTANT HYBRIDS, SALINAS, CALIFORNIA, 1976

6 replications
2 virus treatments
1-row plots, 41 ft. long

Planted: February 11, 1976
Inoculated with BYV-BWYV: April 23, 1976
Harvested: October 12, 1976

		Sugar Yield (lbs/A)			Beet Yield (tons/A)			% Sucrose			Beets/ 100'	% Root Rot
Variety	Description	Check	Inoc.	% Loss	Check	Inoc.	% Loss	Check	Inoc.	% Loss	Number	Check
E539H8	F70-546H3 x ERS 013A	12,360	6,960	43.2	45.32	27.37	39.4	13.63	12.71	6.6	131	0.3
E538H8	F70-546H3 x ERS 413C	12,210	7,270	40.3	46.33	29.51	36.2	13.18	12.30	6.7	124	1.0
E536H8	F70-546H3 x E402,5,6,34	12,160	7,840	35.6	44.91	30.94	30.9	13.55	12.66	6.5	132	0.3
E537H8	F70-546H3 x ERS 813	12,160	7,990	33.7	45.62	31.06	31.3	13.32	12.86	3.5	137	0.9
E506H8	F70-546H3 x E406	12,160	7,440	38.5	45.48	29.48	35.0	13.36	12.59	5.7	125	0.3
E506H29	3536-97H72 x E406	11,910	7,570	35.9	45.55	30.66	32.3	13.05	12.37	5.1	128	0.0
E402H8	F70-546H3 x E302 (RR9)	11,740	8,060	30.5	44.64	32.03	27.7	13.13	12.59	3.9	132	0.6
E536H29	3536-97H72 x E402,5,6,34	11,620	8,270	27.3	45.54	32.97	26.5	12.74	12.53	1.3	133	0.0
US H9B	F67-546H3 x F68-13 (9034)	11,620	7,010	39.3	43.67	27.88	35.9	13.30	12.58	5.3	130	0.9
E534H8	F70-546H3 x E434	11,480	7,580	33.0	43.26	30.35	29.4	13.25	12.48	5.6	124	2.0
US H10B	Lot 1068	11,190	7,500	31.4	43.06	30.07	29.5	12.94	12.47	3.4	134	2.2
E502H8	F70-546H3 x E402,-4,-5	10,880	7,810	27.0	41.73	31.27	24.6	13.02	12.46	3.7	114	1.9
Mean		11,790	7,610	34.7	44.59	30.30	31.6	13.21	12.55	4.8	129	0.9
LSD (.05)		NS	NS	NS	NS	NS	NS	NS	NS	NS	6	1.4
Coefficient of Variation (%)		9.0	11.9	31.6	7.4	10.7	31.1	3.5	2.7	94.0	6	136.6
F value		NS	NS	NS	NS	NS	NS	NS	NS	NS	8**	2.6**

A significant variety x virus treatment interaction occurred only for % root rot.
Means for virus treatments were significantly different for sugar yield, beet yield, % sucrose and % root rot.

TEST 1176-2. VIRUS YELLOWS EVALUATION OF ERWINIA RESISTANT POLLINATORS, SALINAS, CALIFORNIA, 1976

6 replications
2 virus treatments
1-row plots, 41 ft. long

Planted: February 12, 1976
Inoculated with BYV-BWYV: April 23, 1976
Harvested: October 13, 1976

		Sugar Yield (lbs/A)			Beet Yield (tons/A)			% Sucrose			Beets/ 100'	% Root Rot
Variety	Description	Check	Inoc.	% Loss	Check	Inoc.	% Loss	Check	Inoc.	% Loss	Number	Check
F70-546H3	562HO x F63-546 (0036)	12,050	6,190	48.4	42.95	24.43	42.9	14.03	12.67	9.7	135	0.3
E540	ESS F70-13	11,500	7,770	32.3	44.70	31.56	28.9	12.88	12.30	4.4	120	5.9
E502	Inc. E402,-4,-5	11,200	7,310	34.7	43.53	29.66	31.8	12.87	12.32	4.1	122	0.0
E506	Inc. E406	11,140	8,030	27.6	41.34	32.07	22.2	13.48	12.53	7.0	124	0.6
E536	Inc. E402,5,6,34 (C36)	11,120	7,640	31.2	43.30	31.14	28.2	12.83	12.30	4.0	123	0.0
E534	Inc. E434	11,070	8,420	23.9	43.11	34.18	20.4	12.87	12.30	4.2	119	0.0
E539	ERS 013A	11,030	7,950	27.7	43.09	32.68	24.1	12.80	12.17	4.8	125	0.3
468	Inc. 868 (US 75)	10,830	5,320	50.5	41.21	22.59	44.9	13.13	11.77	10.2	118	2.8
F70-13	Inc. F66-13 (0268)	10,710	7,430	30.4	42.90	30.79	28.2	12.48	12.07	3.1	119	5.2
E537	ERS 813	10,710	7,970	24.1	41.16	32.37	19.7	13.03	12.32	5.5	122	3.1
E402	ERS E302 (RR9) (C02)	10,570	6,960	34.2	41.92	28.55	31.9	12.62	12.18	3.4	119	1.7
417	Inc. 713A (C17)	10,290	8,580	15.9	40.77	34.53	14.6	12.62	12.45	1.2	116	10.1
Mean		11,020	7,460	31.7	42.50	30.38	28.2	12.97	12.28	5.1	122	2.5
LSD (.05)		880	670	8.1	NS	2.7	8.6	0.39	0.37	4.1	6	2.2
Coefficient of Variation (%)		6.9	7.8	21.9	6.9	7.8	26.5	2.6	2.6	69.8	6	74.8
F value		2.2*	15.4**	11.9**	NS	14.3**	8.8**	9.7**	3.0**	3.3**	5**	17.1**

Significant variety x virus treatment interactions occurred for sugar yield, beet yield, % sucrose, and % root rot at the 0.01 level.
Means for virus treatments were significantly different for sugar yield, beet yield, % sucrose, and % root rot.

TEST 1276. VIRUS YELLOWS EVALUATION OF YELLOWS RESISTANT X YELLOWS SUSCEPTIBLE GENERATIONS, SALINAS, CA, 1976

6 replications[1/]
2 virus treatments
1 row plots, 22 ft. long

Planted: March 17, 1976
Inoculated with BYV-BWYV: June 4, 1976
Harvested: October 20-21, 1976

			Sugar Yield (lbs/A)			Beet Yield (tons/A)			% Sucrose			Beets/ 100'	% Root Rot
Variety	Generation	Description	Check	Inoc.	% Loss	Check	Inoc.	% Loss	Check	Inoc.	% Loss	Number	Check
4206	F_1	C17 x SP6822-0(B)	11,240	6,100	45.6	42.63	26.97	36.6	13.18	11.25	14.7	144	2.7
Y238	F_2	Inc. F_1	10,220	5,610	44.9	38.22	23.70	37.8	13.37	11.83	11.5	144	2.5
4211	B_1P_2	F_1 x SP6822-0(B)	10,220	5,850	41.2	38.50	24.80	34.1	13.24	11.73	11.4	145	1.1
5221	B_1P_1	F_1 x C17	9,890	6,840	30.2	39.21	28.73	26.0	12.62	11.91	5.6	144	1.1
Y338	F_3	Inc. F_2	9,770	5,580	42.6	36.49	23.23	36.1	13.39	12.04	10.0	150	4.9
417	P_1	Inc. C17	9,380	7,860	16.2	35.64	30.68	13.8	13.16	12.79	2.8	146	8.2
4205	P_2	Inc. SP6822-0(B)	9,320	3,610	61.4	35.11	17.58	50.2	13.25	10.28	22.3	141	1.9
Mean			10,010	5,920	40.3	37.97	25.10	33.5	13.17	11.69	11.2	145	3.2
LSD (.05)			900	900	10.8	3.40	3.19	11.1	0.36	0.52	4.2	NS	3.2
Coefficient of Variation (%)			7.7	12.9	22.7	7.6	10.8	28.0	2.3	3.8	31.7	9	85.3
F value			4.4**	17.3**	14.1**	4.7**	15.0**	8.6**	4.3**	18.3**	19.0**	NS	5.2**

Significant variety x virus treatment interactions occurred for sugar yield, beet yield, % sucrose, and % root rot at the 0.01 level.

Means for virus treatments were significantly different for sugar yield, beet yield, % sucrose, and % root rot.

1/ P_1, P_2, and F_3 were included twice per replication. The F_2 was included three times per replication.

VARIETY TRIALS, BRAWLEY, CALIFORNIA, 1975-76

Location: U.S. Department of Agriculture, Imperial Valley Conservation Research Center

Soil type: Holtville silty clay loam.

Previous crops: Lettuce, 1975; Beets, 1973-74.

Fertilizer used: Preplant: 240 lbs/A 11:48:0 and 260 lbs/A 46:0:0 urea broadcast and disced in before listing.
Sidedressing: 200 lbs/A 46:0:0 urea.

Total fertilization (lbs/A):

N	P_2O_5	K_2O
238	115	0

Summary: 1975-76 Tests, Brawley, California

Test No.	Sowing Date 1975	Test Entries No.	Reps No.	Plot Rows No.	Plot Row Length Ft.	Harvest Date 1976	Test Design
B176	9/10-11	10	10	2	40	5/18-24	Latin sq.
B276	"	20	10	2	40	"	RCB
B376	"	20	10	1	20	"	RCB
B476	"	20	10	1	20	"	RCB
B576	"	112	2	1	24	"	Observation Test

Irrigations: Sprinkler system used for stand establishment. Subsequently, by furrow as needed.

Diseases and insects: Control measures were used as needed throughout growing season.

Sugar analysis: From two ten-beet samples per plot for all trials by Holly Sugar Corporation, Brawley, California.

Remarks: Tests designed and data analyzed by the U.S. Agricultural Research Station, Salinas, California. Stand establishment and general test plot care was under supervision of J. Robertson, USDA, Imperial Valley Conservation Research Center, Brawley, California.

DIPLOID-TRIPLOID TEST, BRAWLEY, CALIFORNIA, 1975-76

10 x 10 Latin square
2-row plots, 40 ft. long

Planted: September 10, 1975
Harvested: May 18-19, 1976

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Number/plot
517H12	546H4 x 417	8,342	34.20	12.20	2.8
517TH12	546H4 x 117T	7,739	33.03	11.74	3.3
517H17	8551H4 x 417	8,207	33.84	12.14	2.2
517TH17	8551H4 x 117T	7,354	31.92	11.53	2.9
517H29	(718H0 x 536-97) x 417	8,107	33.33	12.16	2.2
517TH29	(718H0 x 536-97) x 117T	7,669	32.45	11.82	2.2
417H8	546H3 x 813 (C17)	8,072	33.33	12.11	4.1
417TH8	546H3 x 117T	7,620	32.47	11.74	2.4
517H36	(522H0 x 536-97) x 417	8,018	32.15	12.48	2.1
517TH36	3536-97H23 x 117T	7,324	30.98	11.82	1.3
Mean		7,845	32.77	11.97	2.6
LSD (.05)		333	1.13	0.37	NS
Coefficient of Variation (%)		4.8	3.9	3.4	72.9
F value		9.03**	5.75**	4.94**	NS

**Exceeds the 1% point of significance (F = 2.67).

TEST B276. HYBRID TEST, BRAWLEY, CALIFORNIA, 1975-76

10 replications
2-row plots, 40 ft. long, 32" beds

Planted: September 10, 1975
Harvested: May 20-21, 1976

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolting	Erwinia Rot
		Pounds	Tons	Percent	Number/plot[1/]	Number/plot[1/]
5717H8	F70-546H3 x 4232	9,266	37.66	12.31	19.2	
E536H8	F70-546H3 x C36	9,195	36.47	12.61	9.5	0.5
Y501H31	(562HO x 718) x C01	9,129	35.16	13.00	6.8	
E506H8	F70-546H3 x E406	9,059	35.35	12.81	5.4	0.8
Y522H29	(718HO x 536) x C22	9,005	35.01	12.87	9.0	
517H29	(718HO x 536) x C17	9,004	34.87	12.91	2.9	
517H33	(718HO x 546) x C17	8,980	35.72	12.56	6.9	
517H31	(562HO x 718) x C17	8,940	35.52	12.59	6.3	
Y501H29	(718HO x 536) x C01	8,927	34.04	13.11	4.9	
Y522H8	F70-546H3 x C22	8,885	34.83	12.76	7.6	
Y523H8	F70-546H3 x Y423	8,879	32.92	13.52	5.1	
523-5H8	F70-546H3 x 417-1	8,860	34.23	12.94	2.4	7.4
Y501H8	F70-546H3 x C01	8,821	33.45	13.19	7.2	
Y517H29	(718HO x 536) x Y417	8,566	33.64	12.74	4.1	
US H10B	546H3 x C17 (lot 1068)	8,553	33.76	12.67	5.8	7.6
517HL2	4741H2 x C17	8,431	34.57	12.20	12.8	
Y526H8	F70-546H3 x Y426	8,270	30.74	13.47	7.3	
517HL1	4740H2B x C17	8,194	33.49	12.25	11.4	
5791IH37	Y417HO x 3791-HS(S_1)	8,161	32.98	12.38	20.0	
5791FH37	Y417HO x 3791-HGS(S_1)	8,161	33.91	12.03	23.3	
Mean		8,764	34.42	12.74	8.9	
LSD (.05)		505	1.38	0.54	3.2	
Coefficient of Variation (%)		6.5	4.6	4.8	40.2	
F value		3.9**	8.8**	4.3**	26.1**	

1/ This number will approximately equal %.

TEST B376-1. HYBRID TEST, BRAWLEY, CALIFORNIA, 1975-76

10 X 10 Latin square
1-row plots, 20 ft. long, 32" beds

Planted: September 11, 1975
Harvested: May 22, 1976

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Number/plot[1/]
Y501HL35	(718HO x Y317) x CO1	9,339	33.28	14.02	3.5
Y501HL4	4790H2B x CO1	9,144	32.83	13.93	2.7
517HL18	4791Eaa x C17	9,083	34.27	13.25	7.7
Y501HL3	4789H2B x CO1	9,010	32.16	14.01	3.7
US H10B	546H3 x C17 (lot 1068)	8,841	32.75	13.49	1.1
517HL14	4791aa x C17	8,736	32.58	13.41	2.5
517HL15	4791Baa x C17	8,645	30.61	14.12	3.9
517HL13	3791aa x C17	8,500	31.80	13.41	4.8
517HL17	4791Daa x C17	8,456	32.40	13.04	6.0
517HL16	4791Caa x C17	8,260	30.39	13.60	4.2
Mean		8,801	32.31	13.63	4.0
LSD (.05)		503	1.81	0.46	1.8
Coefficient of Variation (%)		6.4	6.3	3.8	50.6
F value		3.7**	3.3**	5.1**	8.4**

1/ Four times this number will approximately equal % bolting.

TEST B376-2. HYBRID TEST, BRAWLEY, CALIFORNIA, 1975-76

10 X 10 Latin square
1-row plots, 20 ft. long, 32" beds

Planted: September 11, 1975
Harvested: May 22, 1976

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Number/plot1/
517HL5	3791H80 x C17	9,281	34.66	13.40	2.0
5743H37	Y417HO x 3791Clmm	9,097	32.93	13.82	4.8
5791FH37	Y417HO x 3791-HGS(S_1)	9,061	33.71	13.43	7.2
5791IH37	Y417HO x 3791-HS(S_1)	8,848	32.68	13.57	6.2
5791HH37	Y417HO x 3791-HGS(Sib)	8,745	32.26	13.54	7.1
5791JH37	Y417HO x 3791-HS(TC)	8,675	32.16	13.48	3.3
5791GH37	Y417HO x 3791-HGS(TC)	8,593	32.97	13.02	7.2
5742H37	Y417HO x 3791(T-O)Clmm	8,525	30.89	13.81	6.6
5791BH37	Y417HO x 4791B(Mass)	8,505	30.68	13.86	4.4
5791KH37	Y417HO x 3791-HS(Sib)	8,474	31.52	13.43	6.2
Mean		8,780	32.44	13.54	5.5
LSD (.05)		NS	1.79	NS	2.2
Coefficient of Variation (%)		7.3	6.2	4.3	45.0
F value		1.9	3.7**	1.9	5.3**

1/ Four times this number will approximately equal % bolting.

TEST B476-1. OPEN-POLLINATED VARIETY TEST, BRAWLEY, CALIFORNIA, 1975-76

10 X 10 Latin square
1-row plots, 20 ft. long, 32" beds

Planted: September 11, 1975
Harvested: May 24, 1976

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Number/plot1/	Erwinia Rot Number/plot1/
US H10B	546H3 x C17 (lot 1068)	9,357	33.28	14.05	0.7	
Y501	Inc. C01	8,622	29.51	14.62	2.1	
Y522	Inc. C22	8,390	31.84	13.18	8.8	
Y523	Inc. 2 YRS US 15	8,126	28.11	14.47	4.7	
E536(SP)	Inc. 2 ERS C13 (C36)	8,061	30.08	13.39	6.8	0.1
417 Ore	Inc. C17	8,052	29.73	13.55	2.7	5.0
Y517HO (Sp)	Y417HO x Y417	8,006	29.09	13.77	5.0	
E506 (Sp)	Inc. 2 ERS C13	7,769	28.32	13.69	9.4	0.0
523-5 (Sp)	Inc. BRS C17	7,691	28.81	13.35	1.2	
Y526	Inc. 2 YRS US 56/2	7,308	25.18	14.51	5.6	
Mean		8,138	29.39	13.86	4.7	
LSD (.05)		577	2.05	0.43	2.0	
Coefficient of Variation (%)		7.9	7.8	3.5	48.4	
F value		7.5**	9.0**	11.9**	17.9**	

1/ Four times this number will approximately equal %.

TEST B476-2. SELF-FERTILE COMPOSITE TEST, BRAWLEY, CALIFORNIA, 1975-76

10 X 10 Latin square
1-row plots, 20 ft. long, 32" beds

Planted: September 11, 1975
Harvested: May 24, 1976

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Number/plot 1/
5791F	3791-HGS(S_1)aa x A	8,621	30.99	13.90	2.0
5791I	3791-HS(S_1)aa x A	7,931	26.91	14.77	3.2
5791J	3791-HS(TC)aa x A	7,676	26.42	14.53	2.0
5791H	3791-HGS(Sib)aa x A	7,644	28.92	13.22	5.9
5791B	4791B(Mass)aa x A	7,511	26.49	14.19	1.7
5791K	3791-HS(Sib)aa x A	7,347	26.56	13.81	7.0
5743	3791Clmmaa x A	7,147	24.55	14.53	1.7
5791G	3791-HGS(TC)aa x A	7,134	27.26	13.09	5.2
5740	4740aa x A	6,759	23.42	14.46	1.3
5741	4741aa x A	6,726	23.00	14.63	1.3
Mean		7,450	26.45	14.11	3.1
LSD (.05)		535	1.72	0.50	1.5
Coefficient of Variation (%)		8.0	7.3	3.9	54.4
F value		9.0**	15.6**	11.3**	15.5**

1/ Four times this number will approximately equal % bolting.

VARIETY TEST, IMPERIAL VALLEY, CALIFORNIA, 1976
By Holly Sugar Corporation (11901-1)

9 replications, 1 row plots
25 ft. long, 30 in. between rows

Planted: September 11, 1975
Harvested: June 8, 1976

Variety	Description	Ext. Sugar/A	Ext. Sugar/T	Gross Sugar/A	Beets/A	Sucrose	Beets/ 100'	Bolting
		Pounds	Pounds	Pounds	Tons	Percent	Number	Percent
Y522H31	3718H3 x Y422 (C22)	9,740	211.2	13,461	46.1	14.60	128	4.5
Y333H80	2718H5 x Y233	9,594	194.0	13,753	49.4	13.91	128	0.7
US H10B	546H3 x C17	9,365	214.1	12,883	43.8	14.72	131	1.4
Y522H8	F70-546H3 x Y422 (C22)	9,332	217.8	12,727	42.8	14.86	130	3.1
Y501H31	3718H3 x Y401A (C01)	9,280	216.8	12,670	42.7	14.82	128	3.9
517H29	3536-97H72 x 417 (C17)	9,181	214.5	12,609	42.8	14.73	136	0.3
US H9B	546H3 x C413	9,142	212.6	12,590	42.9	14.66	136	2.0
Y331H80	2718H5 x Y231 (C31)	8,978	211.5	12,402	42.4	14.61	131	0.3
517H31	3718H3 x 417 (C17)	8,927	202.8	12,572	44.2	14.26	133	2.4
Y501H8	F70-546H3 x Y401A (C01)	8,602	223.7	11,599	38.4	15.08	132	3.4
Y501H29	3536-97H72 x Y401A (C01)	8,551	212.3	11,795	40.3	14.64	129	5.7
5791FH37	Y417H0 x 3791-HGS (S1)	8,366	201.0	11,810	41.6	14.19	120	13.4
57910H37	Y417H0 x 3791-LIP (S1)	8,364	201.9	11,801	41.6	14.22	119	10.9
5791IH37	Y417H0 x 3791-HS (S1)	7,729	202.1	10,899	38.3	14.24	127	6.4
Test Mean		8,939	209.7	12,398	42.7	14.54	129	4.2
LSD (.05)		883	10.6	1,115	3.7	0.42	--	--
Coefficient of Variation (%)		11	5.4	10	9.2	3.12	--	--
Standard Error of the Mean		315	3.8	398	1.3	0.15	--	--
F value		3.12**	4.64**	3.63**	4.76**	4.62**	--	--

**Exceeds the 1% point of significance (F = 2.36).

VARIETY TEST, TRACY, CALIFORNIA, 1976
By Holly Sugar Corporation (13906-2A)

9 replications, 1 row plots
21 ft. long, 30 in. between rows

Planted: April 23, 1976
Harvested: October 27, 1976

Variety	Description	Ext. Sugar/A	Ext. Sugar/T	Gross Sugar/A	Beets/A	Sucrose	Beets/ 100'
		Pounds	Pounds	Pounds	Tons	Percent	Number
517H31	3718H3 x 417	7,403	186.3	10,119	39.7	12.73	137
Y501H29	3536-97H72 x Y401A	7,172	177.2	10,003	40.7	12.33	137
E506H8	F70-546H3 x E406	7,137	181.5	9,824	39.2	12.51	143
E536H8	F70-546H3 x C36	7,041	179.7	9,774	39.3	12.46	144
523-5H8	F70-546H3 x 417-1	7,031	176.2	9,810	39.8	12.31	141
US H10A	569H3 x C17	7,001	192.5	9,464	36.7	12.97	145
US H10B	546H3 x C17	6,793	179.7	9,398	37.7	12.45	152
417H27	3565H72 x 813	6,726	181.0	9,296	37.1	12.51	136
5791IH37	Y417H0 x 3791-HS(S_1)	6,525	177.5	9,105	36.8	12.37	148
5717H8	F70-546H3 x 4232	6,295	170.9	8,922	37.1	12.08	137
Y522H29	3536-97H72 x Y422	6,279	165.4	9,013	38.1	11.85	143
5791KH37	Y417H0 x 3791-HS(sib)	6,155	180.3	8,482	33.9	12.46	137
517H36	3536-97H23 x 417	6,021	166.7	8,595	36.1	11.91	152
Y501H8	F70-546H3 x Y401A	5,814	174.2	8,130	33.2	12.21	143
517H29	3536-97H72 x 417	5,765	161.5	8,302	35.3	11.68	140
Y517H29	3536-97H72 x Y417	5,556	160.0	8,017	34.4	11.59	131
Test Mean		6,545	175.7	9,141	37.2	12.28	142
LSD (.05)		1,055	NS	1,184	3.8	NS	--
Coefficient of Variation (%)		17	12.9	14	11.0	7.85	--
Standard Error of the Mean		377	7.6	423	1.4	0.32	--
F value		2.32**	1.37	2.61**	2.70**	1.36	--

**Exceeds the 1% point of significance (F = 2.22).

VARIETY TEST, TRACY, CALIFORNIA, 1976
By Holly Sugar Corporation (13907-2B)

9 replications, 1 row plots
21 ft. long, 30 in. between rows

Planted: April 21, 1976
Harvested: November 2, 1976

Variety	Description	Ext. Sugar/A Pounds	Ext. Sugar/T Pounds	Gross Sugar/A Pounds	Beets/A Tons	Sucrose Percent	Beets/100' Number
E506H8	F70-546H3 x E406	9,772	238.7	12,067	40.8	14.77	103
Y501H8	F70-546H3 x Y401A	9,044	233.6	11,262	38.5	14.58	94
523-5H8	F70-546H3 x 417-1	8,917	227.3	11,235	39.1	14.34	110
US H10B	546H3 x C17	8,290	230.4	10,384	35.8	14.46	120
5791KH37	Y417H0 x 3791-HS (sib)	8,258	220.7	10,555	37.4	14.10	114
E536H8	F70-546H3 x C36	8,182	222.8	10,365	36.3	14.18	121
Y501H29	3536-97H72 x Y401A	8,143	222.3	10,320	36.2	14.15	97
US H10A	569H3 x C17	8,001	231.8	10,019	34.5	14.52	120
517H31	3718H3 x 417	7,779	213.7	10,067	36.4	13.83	109
5791IH37	Y417H0 x 3791-HS(S_1)	7,725	225.9	9,751	34.0	14.29	107
417H27	3536H72 x 813	7,413	210.1	9,665	35.3	13.70	101
5717H8	F70-546H3 x 4232	7,200	225.9	9,090	31.9	14.26	92
Y522H29	3536-97H72 x Y422	7,069	191.6	9,538	36.7	12.95	113
517H29	3536-97H72 x 417	6,212	176.2	8,629	34.8	12.31	115
517H36	3536-97H72 x 417	6,169	196.2	8,252	31.3	13.14	119
Y517H29	3536-97H72 x Y417	5,491	184.6	7,524	29.7	12.65	95
Test Mean		7,729	215.7	9,920	35.5	13.89	108
LSD (.05)		1,259	19.5	1,395	4.3	0.75	--
Coefficient of Variation (%)		17	9.7	15	13.0	5.82	--
Standard Error of the Mean		450	7.0	498	1.5	0.27	--
F value		6.24**	7.32**	5.45**	3.53**	7.52**	--

**Exceeds the 1% point of significance (F = 2.22).

Note: Erwinia root rot may have influenced results.

VARIETY TEST, DAVIS-DIXON AREA, SPRING HARVEST, 1976
USDA Hybrids
By American Crystal Sugar Company
524-7

8 x 8 Latin square
2 row plots, 25 ft. long, 30 in. rows

Planted: May 5, 1975
Harvested: March 7-9, 1976

Variety	Description	Acre Yield Gross Sugar Pounds	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Recov. Sugar/ton Pounds	Amino N PPM	Na PPM	K PPM	Impurity Value
Y401H31	(562HO x 718) x Y201	13,092	11,121	41.1	16.0	271	891	755	1943	15961
US H10B	546H3 x C17	12,749	11,011	39.4	16.2	280	822	631	1850	14645
Y322H80	(564HO x 718) x Y222A	12,683	10,654	40.7	15.6	262	932	685	2130	16580
Y401H33	(718HO x 546) x Y201	12,600	10,816	39.3	16.0	275	775	827	1943	15114
Y301H8	546H3 x Y201	12,598	10,829	38.6	16.3	280	842	759	1842	15261
Y401H29	(718HO x 536-97) x Y201	12,477	10,671	39.3	15.9	272	793	792	1996	15297
Y301H80	(564HO x 718) x Y201	12,463	10,625	39.1	15.9	271	841	757	2022	15699
Y331H8	(562HO x 546) x Y231	11,741	9,862	37.3	15.7	264	903	883	2066	16837
Mean		12,551	10,699	39.4	15.9	272	850	761	1974	15674
HSD (.05)		NS	NS	NS	0.6	13.8	121.1	150.8	160.7	1565.6
Coefficient of Variation (%)		7.1	7.3	6.8	2.2	3.2	8.9	12.4	5.1	6.3
F value		NS	NS	NS	3.5**	4.7**	4.2**	5.5**	7.9**	4.7**

**Exceeds the 1% point of significance (F = 3.1).

VARIETY TEST, DAVIS-DIXON AREA, SPRING HARVEST, 1976
USDA Hybrids
By American Crystal Sugar Company
524-8

8 x 8 Latin square
2 row plots, 25 ft. long, 30 in. rows

Planted: May 6, 1975
Harvested: March 16-18, 1976

Variety	Description	Acre Yield Gross Sugar Pounds	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Recov. Sugar/ton Pounds	Amino N PPM	Na PPM	K PPM	Impurity Value
Y301H8	546H3 x Y201	12,059	10,692	36.1	16.7	297	539	827	1851	12642
Y301H80	(564H0 x 718) x Y201	11,936	10,413	36.5	16.3	285	552	945	2120	13851
Y331H8	(562H0 x 546) x Y231	11,622	10,122	34.5	16.9	294	600	940	2183	14443
Y401H33	(718H0 x 546) x Y201	11,592	10,258	34.6	16.8	297	479	913	2039	12841
Y401H29	(718H0 x 536-97) x Y201	11,519	10,053	35.4	16.3	284	499	1092	2093	13791
Y401H31	(562H0 x 718) x Y201	11,437	9,937	34.7	16.5	287	609	949	2128	14422
Y322H80	(564H0 x 718) x Y222A	10,469	8,984	32.9	15.9	273	674	945	2137	15053
US H10B	546H3 x C17	10,428	9,236	31.6	16.5	292	538	799	1878	12603
Mean		11,383	9,962	34.5	16.5	288	561	926	2054	13706
HSD (.05)		1,425	1,270	4.2	0.6	13.2	82.2	201.9	203.5	1384.9
Coefficient of Variation (%)		7.9	8.0	7.6	2.1	2.9	9.2	13.7	6.2	6.3
F value		3.8**	4.2**	3.1**	6.5**	7.7**	12.2**	3.9**	7.5**	9.1**

**Exceeds the 1% point of significance (F = 3.1).

VARIETY TEST, DAVIS-DIXON AREA, SPRING HARVEST, 1976
USDA Hybrids
By American Crystal Sugar Company
524-11

8 x 8 Latin square
2 row plots, 25 ft. long, 30 in. rows

Planted: May 5, 1975
Harvested: March 10-12, 1976

Variety	Description	Acre Yield Gross Sugar	Acre Yield Recov. Sugar	Acre Yield Beets	Sucrose	Recov. Sugar/ton	Amino N	Na	K	Impurity Value
		Pounds	Pounds	Tons	Percent	Pounds	PPM	PPM	PPM	
417H27	(718HO x 565) x C17	12,296	10,624	38.0	16.2	280	838	575	1861	14625
417H29	(718HO x 536-97) x C17	12,002	10,331	37.1	16.2	279	824	644	1959	14983
417H21	3536-97HO x C17	11,963	10,360	35.9	16.7	289	873	572	1835	14883
US H10B	546H3 x C17	11,866	10,418	36.0	16.5	290	745	570	1727	13395
Y417H31	(562HO x 718) x Y317	11,566	9,994	35.8	16.2	279	822	521	2003	14634
417H34	(705HO x 546) x C17	11,502	10,032	34.8	16.5	288	794	607	1784	14123
417H33	(718HO x 546) x C17	11,493	9,978	35.6	16.1	280	754	635	1922	14190
417H28	(562HO x 536-97) x C17	11,305	9,744	35.2	16.1	277	872	633	1721	14807
Mean		11,749	10,185	36.0	16.3	283	815	595	1851	14455
HSD (.05)		NS	NS	3.1	NS	NS	147.0	114.1	188.0	1850.7
Coefficient of Variation (%)		6.2	6.6	5.3	2.7	3.8	11.3	12.0	6.4	8.0
F value		NS	NS	2.4*	NS	NS	2.2*	2.8*	6.3**	NS

*Exceeds the 5% point of significance (F = 2.2).

VARIETY TEST, DAVIS-DIXON AREA, SPRING HARVEST, 1976
USDA Hybrids
By American Crystal Sugar Company
524-12

8 x 8 Latin square
2 row plots, 25 ft. long, 30 in. rows

Planted: May 6, 1975
Harvested: March 15-16, 1976

Variety	Description	Acre Yield Gross Sugar Pounds	Acre Yield Recov. Sugar Pounds	Beets Tons	Sucrose Percent	Recov. Sugar/ton Pounds	Amino N PPM	Na PPM	K PPM	Impurity Value
US H10B	546H3 x C17	10,434	9,309	31.0	16.8	300	567	718	1672	12075
417H33	(718H0 x 546) x C17	10,429	9,125	32.4	16.1	282	585	840	1937	13343
417H27	(718H0 x 565) x C17	10,072	8,818	31.4	16.0	281	606	765	1939	13284
417H34	(705H0 x 546) x C17	9,982	8,849	30.0	16.7	296	552	827	1748	12512
Y417H31	(562H0 x 718) x Y317	9,846	8,513	30.9	15.9	275	679	817	2043	14418
417H28	(562H0 x 536-97) x C17	8,968	7,786	27.9	16.1	279	675	874	1842	14072
417H29	(718H0 x 536-97) x C17	8,862	7,702	27.9	15.9	276	599	893	1987	13782
417H21	3536-97H0 x C17	8,562	7,427	26.6	16.1	279	699	858	1851	14273
Mean		9,644	8,441	29.8	16.2	284	620	824	1877	13470
HSD (.05)		1,097	1,010	3.0	0.6	14.6	103.8	NS	211.7	1581.0
Coefficient of Variation (%)		7.1	7.5	6.4	2.2	3.2	10.5	15.8	7.1	7.4
F value		9.2**	10.1**	9.4**	7.4**	8.2**	5.9**	NS	7.0**	5.7**

**Exceeds the 1% point of significance (F = 3.1).

VARIETY TESTS, CLARKSBURG, CALIFORNIA, FALL HARVEST, 1976
USDA Hybrids
By American Crystal Sugar Company

8 x 8 Latin square
2-row plots, 25 ft. long

Planted: April 1976
Harvested: September 1976

624-3 (I)

Variety	Description	Acre Yield: Gross Sugar Pounds	Acre Yield: Recov. Sugar Pounds	Acre Yield: Beets Tons	Sucrose Percent	Recov. Sugar/ton Pounds	Amino N PPM	Na PPM	K PPM	Recov. Sugar Percent
E506H8	546H3 x E406	7,953	6,509	28.8	13.9	227	831	1597	1282	81.8
Y501H29	(718H0 x 536) x C01	7,886	6,357	30.6	12.9	209	660	2088	1202	80.6
E536H8	546H3 x C36	7,742	6,338	27.9	13.9	227	841	1602	1268	81.8
Y522H29	(718H0 x 536) x C22	7,197	5,692	29.3	12.3	195	733	1979	1289	79.0
US H10B	Standard check	7,145	5,694	28.6	12.4	198	721	1940	1300	79.5
517H36	(522H0 x 536) x C17	6,673	5,304	26.0	12.9	205	816	1943	1205	79.4
517H29	(718H0 x 536) x C17	6,361	5,065	25.8	12.3	197	699	1929	1339	79.5
Y517H29	(718H0 x 536) x C16	6,341	5,002	26.3	12.1	190	737	1926	1305	78.5
Mean		7,162	5,745	27.9	12.8	206	755	1876	1274	80.0
HSD (.05)		1,147	927	4.3	1.1	22.8	154.2	406.2	NS	2.7
Coefficient of Variation (%)		10.0	10.1	9.7	5.3	6.9	12.8	13.6	8.2	2.1
F value		6.7**	8.5**	3.3**	8.4**	8.0**	3.8**	3.9**	NS	4.5**

624-5 (II)

Variety	Description	Acre Yield: Gross Sugar Pounds	Acre Yield: Recov. Sugar Pounds	Acre Yield: Beets Tons	Sucrose Percent	Recov. Sugar/ton Pounds	Amino N PPM	Na PPM	K PPM	Recov. Sugar Percent
Y501H31	(562H0 x 718) x C01	8,133	6,642	30.0	13.6	222	753	1889	1121	81.6
US H10B	Standard check	7,409	5,890	28.2	13.1	209	878	1816	1281	79.4
517H33	(718H0 x 546) x C17	7,249	5,854	28.0	13.0	210	751	1721	1348	80.5
5791IH37	C16H0 x 3791-HS (S_1)	7,090	5,675	26.2	13.4	215	936	1675	1279	79.9
5791KH37	C16H0 x 3791-HS (sib)	6,977	5,544	26.3	13.3	212	933	1708	1328	79.5
5717H33	(718H0 x 546) x 4232	6,762	5,618	24.6	13.8	229	703	1571	1302	83.1
523-5H8	546H3 x 417-1	6,643	5,234	27.0	12.3	194	800	1966	1160	78.7
417H34	(706H0 x 546) x C17	6,516	5,213	25.2	13.0	207	810	1853	1224	79.9
Mean		7,097	5,709	27.0	13.2	212	820	1775	1255	80.3
HSD (.05)		1,058	940	3.3	1.0	22.0	160.3	249.1	118.3	2.7
Coefficient of Variation (%)		9.3	10.3	7.6	4.9	6.5	12.3	8.8	5.9	2.1
F value		4.8**	4.7**	5.9**	4.0**	4.5**	6.0**	5.5**	9.4**	5.4**

DATA ON U.S.D.A. VARIETIES TESTED
BY
SPRECKELS SUGAR COMPANY

TEST AREAS:		Spreckels, Calif.			Mendota, Calif.		
Variety	Description	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar
517H29	3536-97H72 x 417				4.28	34.3	12.5
517H36	3536-97H23 x 417	3.846	39.08	9.8	3.90	30.1	12.9
Y-517H29	3636-97H72 xY417				3.98	32.6	12.2
Y-501H29	3636-97H72 xY401A	4.810	43.55	11.0	4.47	34.7	12.9
Y-522H29	3636-97H72 xY422	4.335	42.21	10.3			
E506H8	F70-546H3 x E406	4.001	40.12	9.9	5.02	38.1	13.2
E536H8	F70-546H3 x E402	3.924	39.33	9.6	4.85	38.6	12.6
523-5H8	F70-546H3 x 417-1	4.117	38.76	10.6			
5717H8	F70-546H3 x 4232						
USH9B1	546H4 x C413	4.167	42.35	9.8	4.51	36.4	12.4
General Mean		4.214	40.50	10.4	4.70	36.7	12.8
LSD @ P = .05		0.335	2.52	.7	0.59	4.3	NS
LSD @ P = .01		0.438	3.28	.9	0.78	5.7	NS
S E of Mean		0.1219	0.1952	0.0210	0.782	1.526	0.338
S E % of Mean		2.89	2.26	2.14	4.49	4.16	2.63
# Var. in Test			12			16	
Planting Date		January 7, 1976			March 23, 1976		
Harvest Date		October 19, 1976			September 28, 1976		

INTERSPECIFIC HYBRIDIZATION

VULGARIS-PROCUMBENS HYBRIDS

Helen Savitsky

Cytological data indicate that diploid nematode-resistant plants have been obtained after crossing over by reciprocal translocation of a terminal section of the B. procumbens chromosome to the end of a B. vulgaris chromosome with the loss of only a small segment of the B. vulgaris chromosome. The position of the B. procumbens segment at the end of a B. vulgaris chromosome indicates that the gene for nematode resistance is located near the end of the chromosome arm. Transmission of a small segment of the B. procumbens chromosome permitted the transfer of the gene for nematode resistance without deleterious genes of B. procumbens. The diploid nematode-resistant plants do not show the presence of deleterious genes. They have lost the genes for early bolting, tumor formation, and very elongated leaves that are linked in the B. procumbens chromosome with the gene for nematode resistance. The diploid nematode-resistant plants that have been grown in the greenhouse have well developed foliage, good roots, and can not be distinguished from normal diploid sugarbeets. However, the rate of resistance transmission in these plants is not yet sufficient for production of commercial nematode-resistant varieties. Therefore, in 1976 work was concentrated on selection for an increased rate of resistance transmission and the development of homozygous nematode-resistant lines.

Three kinds of experiments were conducted in 1976:

(1) Selection of F_3 nematode-resistant plants in the progenies of F_2 plants with higher rates of transmission (20% and over). From 3,750 F_3 plants tested for resistance in 1976, 588 resistant plants have been selected. Some of the selected F_3 progenies had transmission rates up to 30%.

(2) The transmission rate by female and male gametes has been studied. The progenies from reciprocal crosses of 25 F_2 resistant plants with susceptible plants were tested for resistance. Of 1,462 plants derived from transmission by female gametes of nematode-resistant plants 24.0% were resistant, and of 1,308 plants derived from pollen transmission 12.8% were resistant. The percentage of resistant plants in the progenies of individual plants derived from transmission by female gametes varied from 11.0 to 31.4%, compared with 0 to 19.7% for transmission by pollen. The B. vulgaris chromosome bearing the B. procumbens segment is transmitted by pollen although at a lower frequency than by egg cells. The rate of transmission of the entire B. procumbens chromosome by pollen in trisomics was 0-1.1% which is much lower than the transmission rate of the B. vulgaris chromosome with the B. procumbens segment. Transmission of nematode resistance by male gametes is very important because it permits the selection of nematode-resistant plants in the progenies obtained from pollen transmission and enables us to obtain homozygous nematode-resistant lines. The selection of

nematode-resistant plants derived from pollen transmission opens new possibilities. These plants are obtained from pollen grains that could compete in the rate of pollen tube growth with pollen grains lacking the B. procumbens segment. Selection for increased transmission rates in these plants may be more successful than selection in plants derived from female gametes. The 130 plants obtained in 1976 from pollen transmission will be used for further hybridization and selection. Reciprocal crossing of nematode-resistant beets with susceptible beets is being continued and selections will be made of plants with the best pollen transmission rates.

(3) In order to develop homozygous nematode-resistant lines, plants with higher transmission rates should be selected and intercrossed or crossed with inbreds. Experiments in this direction have been started. One hundred and thirty F_2 and F_3 nematode-resistant plants have been intercrossed in pollination bags to induce the formation of homozygous zygotes with two chromosomes bearing the B. procumbens segment. Seventeen F_2 and F_3 nematode-resistant plants have been pollinated by curly top resistant inbreds. Many F_1 hybrids have been obtained from hybridization with these inbreds. These F_1 hybrids are now being tested for resistance. The self-fertile plants will be selected from resistant F_1 hybrids. The development of homozygous nematode-resistant lines is very important. Pairing may be improved or may be normal when both partners of bivalents possess the B. procumbens segment. All offspring of homozygous plants will be resistant and this will facilitate the development of nematode-resistant commercial varieties.

The cytological study of diploid nematode-resistant plants is being continued.

VULGARIS-COROLLIFLORA HYBRIDS

Helen Savitsky and J. S. McFarlane

Because of the low transmission of curly top resistance to the B_6 generation (2-3%) the experiments were repeated again in 1975 and in 1976 with B_1, B_2,, and B_3 lines. Thirty B_1 and B_2 curly top resistant plants were selected in 1975 after three inoculations with a virulent strain of curly top virus. The selected plants had poor pollen but seeds were obtained from them in 1976 after pollination with pollen from diploid sugarbeets. From their progenies, 240 plants were inoculated three times with curly top virus, and 26 resistant plants were selected. Seeds were obtained from these plants. Their progenies will be tested for curly top resistance.

Studies of Interspecific Hybridization in *Beta* Species

M. H. Yu

Resistance in the Wild Beet Species

The species of *Beta* in the Patellares section are highly resistant to cyst nematode and several other pathogens. Interspecific crosses can be made between cultivated sugarbeets and the Patellares species. Although the hybrids are mostly sterile, this is a major method of incorporating desirable exotic germplasm into the sugarbeet lines.

Seed of more than 50 strains of the Patellares section were collected from various sources. Germination of these seeds was generally poor, in spite of the practice of scarification with sulphuric acid before planting. Because of the age of the seeds, no seedlings were obtained in several strains.

To screen for nematode resistance, seedlings were transplanted to cylinders that contained nematode-infested soil. Each cylinder was inoculated one week after transplanting with 2000 nematode larvae to insure a high nematode population. Tests were conducted under controlled temperatures. Plants were examined six weeks after transplanting. The results showed that plants of all three Patellares species were highly resistant, but not immune, to the nematodes. Only a small proportion of plants were found to have cysts attached to the roots (Table 1). The percentage of plants with cysts were *B. patellaris* 4.59%, *B. webbiana* 7.94%, and *B. procumbens* 1.71%. With further larval inoculation, fewer cysts were detected on these plants. Nematode resistance in the wild species seems to have increased as the plants matured. Progenies of the selected individual plants will be investigated for resistance at a later time.

Mature plants of the wild species were also tested for curly top resistance. Leafhoppers that had acquired curly top virus from infected host plants were used as vectors. Symptoms of curly top did not appear on the wild beet plants. Nonviruliferous leafhoppers were, therefore, fed on the wild beets to recover the virus and then transferred to the susceptible sugarbeet plants. Resistance was determined by the performance of these check plants. The results showed that only two *patellaris* plants were susceptible to curly top. This indicates that the mature plants of the wild species are highly resistant to this disease. According to Murphy and Giddings (1954, Proc. ASSBT, Part 2, pp. 99-103), the *B. patellaris* plants they studied were found to be curly top susceptible.

Another virus disease, beet western yellows, was transmitted to the wild beet plants by the use of green peach aphids. The virus was acquired from infected shepherd's-purse by the aphids and transmitted to the wild beets. No western yellows symptoms were readily observable. However, from the limited number of recovery sugarbeet plants that have been examined, the susceptibility of the wild species plants to the beet western yellows is obvious. Tests for both curly top and beet western yellows are being conducted with the help of Dr. J. E. Duffus, and are not yet finished.

Nematode Resistance in the Progenies of the Trisomic and Diploid Sugarbeets

All the nematode resistant sugarbeets in this study were progenies of the interspecific hybrids between B. vulgaris and B. procumbens, after several generations of backcrossing. Both trisomic and diploid plants were included. In 1973, a group of resistant trisomic plants (Table 2, group A) were irradiated with gamma-rays on the inflorescence. Plants were grouped according to the maturity of flower buds. The stages were: (1) just after initiation of floral buds, (2) about a week before anthesis, (3) two to four days from anthesis, (4) just prior to anthesis, and (5) at anthesis. The doses used on these plants were 700r, 1000r, 1300r, 1600r, and 1900r. The irradiated plants were crossed with susceptible sugarbeet lines by means of bagging. A total of 4,424 progeny plants of this group were tested for nematode resistance. The average resistance transmission rate was 9.88%, with a range between 2.5% and 17.86% for individual treated plants. The rate was slightly higher for the exposure doses above 1300r, and for the maturity stage of 2 to 8 days before anthesis; however, the difference was not significant. There were considerable variations among individual plants within each treatment. Cytologically, the occurrence of chromosomal abnormality was rare, and was not obviously different from the non-treated trisomics. This indicates that the dosage used under 1900r is insufficient to increase the rate of chromosomal aberration, or recombination.

Another selection of resistant trisomics (group B) were irradiated at 3 to 8 days before anthesis, with gamma-rays 2000r, 2500r, and 2800r. The treated plants were also backcrossed to the sugarbeet lines. The results showed that the 2800r treated plants yielded a lower seed weight. This might indicate that 2800 rentgen units of exposure has been strong enough to influence the normal meiotic behavior of the plants. The chromosomal abnormalities among the resistant plants of this group were higher than that of group A (9.88% vs. 5.26%). The average percentage of resistant progenies in group B was 13.63%, which was also higher than for the A group. Whether this difference can be attributed to the genotype, the dosage that was used, or both is yet to be determined.

The untreated trisomics (group C) were progenies of those resistant trisomics that were selected for a higher transmission rate. After one test, 15.54% of plants were found to be cyst free.

During 1976 a total of 6,896 trisomic progeny plants were screened for nematode resistance. A diploid resistant sugarbeet has not been obtained; but many aneuploids (other than 19 chromosomes) were observed instead. Further investigation of nematode resistance should probably include the densely ionizing radiations, such as fission neutrons, to induce chromosome alterations in the trisomics.

Tests with the diploid resistant plants have been partially completed. The resistance transmission rate of '505K' (the HS selection) was estimated as 28%, and that of '51501' was 16% after the first check. Another diploid resistant plant '52261' (based on the root tip chromosome counts, 2n = 18, in 1975), however, produced trisomic (19 chromosomes) resistant progeny. This plant was obviously a sectorial chimera with 18 chromosome roots and 19 chromosome shoots.

Table 1. Resistance of the wild beet species to cyst nematode, curly top, and beet western yellows.

Species	Pathogens	No. of plants tested*			% of
		Total	Resistant	Susceptible	resistance
B. procumbens	Nematode	292(12)	287(12)	5(2)	98.3
	Curly top	31(6)	31(6)	0	100.0
	Western yellows	10(2)	4(2)	6(2)	40.0
B. webbiana	Nematode	63(7)	58(7)	5(3)	92.1
	Curly top	16(5)	6(5)	0	100.0
	Western yellows	3(1)	2(1)	1(1)	66.7
B. patellaris	Nematode	218(22)	208(22)	10(5)	95.4
	Curly top	47(22)	45(22)	2(2)	95.7
	Western yellows	10(5)	0	10(5)	0

* Figures in the parentheses were the numbers of strains included.

Table 2. Nematode resistance in the progenies of the trisomic and diploid NR sugarbeets.

Parent plant	Gamma-rays treatment	Total no. of plants	No. of res. plants	% of resistance
Trisomics:				
A	700 r	1,532(20)*	145	9.46
	1,000 r	945(12)	91	9.63
	1,300 r	1,058(15)	110	10.40
	1,600 r	806(8)	82	10.17
	1,900 r	83(1)	9	10.84
		4,424	437	9.88
B	2,000 r	450(3)	59	13.11
	2,500 r	363(3)	43	11.85
	2,800 r	449(3)	70	15.59
		1,262	172	13.63
C	(untreated)	888(10)	138	15.54
others		322(4)	21	6.52
Diploids:				
505K	(untreated)	629(6)	179	28.46
51501	(untreated)	248(1)	40	16.13
52261	(untreated)	101(1)	6**	5.94

* Figures in the parentheses were numbers of strains involved.
** The resistant progenies were trisomic.

Comparison of One Cycle of S_1, Test-cross, and Full-sib (Paired-plant) Selection in a Sugarbeet Composite Population

R. T. Lewellen, I. O. Skoyen, J. S. McFarlane

Population improvement in field crops has received increasing attention from plant breeders in recent years. While considerable data are available for different selection procedures in corn, sorghum, alfalfa, etc., little information has been published for sugarbeet. Progress from selection is dependent upon the presence of genetic variability in the population and accurate evaluation of the breeding merits of the parental plants. To evaluate breeding merit S_1 progeny testing has received increasing attention among corn breeders and has in general received favorable reviews. Half-sib and full-sib family testing and test-cross evaluation have had a more general use for population improvement and for recurrent selection programs than S_1 evaluation. The preliminary results of one cycle of selection using S_1, test-cross, and full-sib evaluation are described in this report. Selection was practiced for gross sugar (GS), sucrose concentration (% S), amino nitrogen, sodium, potassium, and impurity index.

The population used for this study is a relative broadbase composite of self-fertile and self-sterile lines adapted to the needs of California. After intercrossing about 30 self-fertile and two yellows resistant, self-sterile lines, the F_1 plants were selfed. Mendelian male sterility (a_1a_1) was used to make the original crosses. The population segregates for both monogerm and multigerm seed types. F_2 stecklings were grown in a spatial isolation and composite seed was harvested only off of the aa plants. The composite was increased twice more in isolation with seed harvested only off of the aa plants. The final synthesis is referred to as the unselected C0 composite.

In 1973, induced stecklings from Oregon were planted at random into hills in a breeding nursery. Stecklings of 546H3 also were planted into each hill. Just prior to anthesis, hills which contained one S_o fertile plant (A_1), one matching S_o sterile plant (aa), and two or three completely sterile 546H3 plants were identified. These sets of plants were enclosed under a large muslin bag. S_1 seed was harvested off of the selfed A_1 plant. FS seed was harvested off of the aa plant. TC seed was harvested off of the 546H3 plants. Sufficient seed was obtained of all three progeny types from 96 hills to be included in field evaluations.

In 1974, three separate trials were planted, one each for the S_1, FS, and TC progeny types. Each entry was planted into an incomplete block design with four replications. Plots were single-rows, 20 ft. long. At harvest, the plots were evaluated for the components of yield and impurity. Also in 1974, remnant seed of each S_1 and FS family was planted in a steckling nursery in Oregon.

Approximately 10% selection intensity was used, i.e., the C1 Syn 1 composites were synthesized from 9 or 10 families. For the synthesis of the selections based on S_1 or TC merit, S_1 stecklings were used. For the synthesis of the selections based on FS merit, FS stecklings were used. Selections for GS and % S were made on the basis of S_1, FS, and TC performance. Selections

for NH_2-N, Na, K, and impurity index were made only on the basis of S_1 merit. Where possible, equal numbers of stecklings from each selected family were grown in isolation in 1975. The seed harvested off of the aa plants was composited and called the C1 Syn 1. Within each isolation, stecklings of 546H3 and Y417HO were grown so that hybrid seed could be obtained.

Response to selection was determined by direct comparison of the CO and C1 in replicated trials in 1976 (tests 876-1, 876-2, and 876-3). The CO and C1 populations per se (test 876-1), their hybrids with 546H3 (test 876-2) and their hybrids with Y417HO (test 876-3) were planted in separate randomized complete block designs at Salinas. Tests which included some of the C1 populations and hybrids were also planted at Brawley (test B376-2 and B476-2).

The results of these tests are summarized in the tables (test 876). Only a brief narrative of these preliminary results is given below.

Selection for gross sugar (GS)--S_1 evaluation: Selection resulted in a significant increase of about 10% for GS and beet yield for the C1 population per se, but did not result in a significant increase for the hybrid combinations. TC evaluation: Selection did not significantly change the yield performance. FS evaluation: Selection gave a significant increase in beet yield for both the C1 per se and the two hybrid combinations. This FS selection produced the greatest increase in the hybrids for sugar and beet yield, thus suggesting that it is more efficient than S_1 or TC evaluation at identifying gene action for combining ability.

Selection for % sucrose (% S)--S_1 evaluation: Selection significantly increased the % S and GS in the C1 per se but not in the hybrids. TC evaluation: Produced nearly identical results as the S_1 selection. FS evaluation: Selection significantly increased the % S for only the C1 per se. Because % S is supposed to be due primarily to additive gene effects, the lack of transmission of the increased sucrose level of the C1 to the hybrids is somewhat puzzling.

S_1 selection for components of impurity--NH_2-N: Selection resulted in about 40% less NH_2-N in the C1 per se than in the CO and about 12% reduction in the hybrids with 546H3 and Y417HO. None of these reductions were significantly different, however. This selection for reduced NH_2-N apparently caused an increase in the Na concentration in the C1 per se. When some S_1 progenies were evaluated for NH_2-N, we could not obtain a clear filtrate and thus extremely high values were obtained. These S_1 lines were not included in the synthesis to produce the C1. Therefore, we are not certain whether our selection was actually based on lower NH_2-N values, or on the ability to obtain clear filtrate. Sodium: Selection resulted in a significant reduction of about 34% in the Na concentration of the C1 per se and about half that in the hybrids. Selection for low Na caused an increase in the concentration of NH_2-N. Potassium: Selection caused a significant reduction of about 20% in the concentration of K in the C1 per se and slight reductions in the hybrids. This selection for decreased K also produced a decreased concentration of Na, whereas NH_2-N remained relatively unchanged. Impurity index: Selection for lower impurity index had about the same effects as the selection for reduced NH_2-N. Probably most of the variation in the impurity index was accounted for by the differences in NH_2-N. Selections for lower NH_2-N and impurity index caused about equal reductions in impurity value and KSL, whereas selection for only low Na caused an increase in the impurity value and KSL.

Test 876. Relative performance of Cl SYN 1 populations and hybrids of 791 for yield, Salinas, California, 1976

Cycle	Sugar Yield (lbs/A)			Beet Yield (tons/A)			% Sucrose		
	per se	546H3 x	Y417HO x	per se	546H3 x	Y417HO x	per se	546H3 x	Y417HO x
CO unselected composite	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Cl Syn 1 GS by S_1 eval.	111.2	101.7	101.2	109.9	103.5	103.7	101.2	98.2	97.6
Cl Syn 1 GS by TC eval.	100.0	101.3	101.1	99.2	100.0	103.2	100.8	101.2	98.1
Cl Syn 1 GS by FS eval.	102.9	105.2	105.3	106.6	104.3	106.5	96.5	100.8	98.8
Cl Syn 1 % S by S_1 eval.	108.1	100.9	97.3	100.9	99.6	98.0	107.2	101.2	99.2
Cl Syn 1 % S by TC eval.	107.9	101.1	97.0	101.1	99.8	97.3	107.0	101.1	99.5
Cl Syn 1 % S by FS eval.	102.8	96.6	97.2	97.1	96.0	97.0	106.0	100.6	100.2
Mean	10,600	11,260	11,500	38.61	41.11	43.02	13.73	13.69	13.37
LSD (.05) as %	6.6	NS	NS	3.8	4.3	4.8	4.4	NS	NS
Coefficient of variation	6.6	5.7	6.1	3.8	4.3	4.7	4.4	3.0	3.6
F value	3.2**	NS	NS	10.9**	3.3**	4.7**	6.5**	NS	NS

TEST 876. RELATIVE PERFORMANCE OF C1 SYN 1 POPULATIONS AND HYBRIDS OF 791 FOR COMPONENTS OF IMPURITY, SALINAS, CALIFORNIA, 1976

Cycle	NH_2-N (ppm) per se	NH_2-N (ppm) 546H3 x	NH_2-N (ppm) Y417HO x	Sodium (ppm) per se	Sodium (ppm) 546H3 x	Sodium (ppm) Y417HO x
C0 unselected composite	100.0	100.0	100.0	100.0	100.0	100.0
C1 Syn 1 NH_2-N by S_1 eval.	60.4	88.9	87.6	118.7	99.9	119.4
C1 Syn 1 Na by S_1 eval.	139.3	110.9	91.0	66.1	83.7	86.6
C1 Syn 1 K by S_1 eval.	106.6	93.4	91.1	71.6	94.1	99.0
C1 Syn 1 Imp. Ind. by S_1 eval.	64.8	99.6	79.3	104.3	111.2	115.1
Mean	1170	660	590	590	610	580
LSD (.05) as %	40.4	14.1	14.2	20.0	NS	20.7
Coefficient of variation	39.5	13.8	13.8	19.5	19.8	20.2
F value	6.1**	3.0*	2.9*	12.5**	NS	3.2*

Cycle	Potassium (ppm) per se	Potassium (ppm) 546H3 x	Potassium (ppm) Y417HO x	Impurity value per se	KSL (lbs/A) per se
C0 unselected composite	100.0	100.0	100.0	100.0	100.0
C1 Syn 1 NH_2-N by S_1 eval.	99.2	95.1	87.3	76.8	76.8
C1 Syn 1 Na by S_1 eval.	94.8	96.3	106.7	119.8	116.7
C1 Syn 1 K by S_1 eval.	79.9	87.3	96.2	95.9	97.2
C1 Syn 1 Imp. Ind. by S_1 eval.	104.8	97.5	99.4	79.3	76.5
Mean	1880	1560	1570	18,510	2070
LSD (.05) as %	7.4	NS	8.8	26.1	24.9
Coefficient of variation	7.2	9.4	8.6	25.5	24.3
F value	15.2**	NS	5.6**	4.2**	4.5**

TEST 876-1. COMPARISON OF S_1, FULL-SIB, AND TEST-CROSS EVALUATION: 791 PER SE, SALINAS, CALIFORNIA, 1976

8 replications
2 row plots, 30 ft. long

Planted: February 3-4, 1976
Harvested: September 15-17, 1976

Variety	Cycle 1/	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Amino N PPM	Na PPM	K PPM	Impur. Index	Recov. Sugar/A Pounds	Recov. Sugar Percent
5791F	Cl Syn 1 GS by S_1 eval.	11,250	41.55	13.54	820	610	2040	1140	9,330	82.9
US H10B		11,180	40.72	13.73	980	610	1860	1210	9,150	81.9
5743	Inc. monogerm sel. CO	11,030	38.34	14.38	1220	400	1720	1240	8,960	81.4
5791I	Cl Syn 1 % S by S_1 eval.	10,940	38.17	14.34	1890	510	1770	1780	8,060	73.3
5791J	Cl Syn 1 % S by TC eval.	10,920	38.22	14.31	1110	460	1840	1230	8,930	81.6
5791N	Cl Syn 1 K by S_1 eval.	10,680	38.25	13.97	1330	460	1570	1350	8,520	79.7
5791H	Cl Syn 1 GS by FS eval.	10,420	40.30	12.91	1100	800	2180	1510	8,080	77.4
5791K	Cl Syn 1 % S by FS eval.	10,410	36.71	14.18	1110	480	1880	1240	8,480	81.4
5791B	Inc. mass sel. CO for YR	10,330	37.06	13.96	1600	520	2090	1660	7,740	75.1
5791G	Cl Syn 1 GS by TC eval.	10,130	37.51	13.48	1030	520	2030	1290	8,190	80.7
5791M	Cl Syn 1 Na by S_1 eval.	10,120	36.93	13.73	1730	420	1860	1710	7,530	74.3
3791	CO unselected composite	10,120	37.82	13.38	1250	640	1970	1480	7,900	77.8
5791P	Inc. Powd. Mild. sel. CO	9,960	37.03	13.45	950	570	2030	1230	8,110	81.5
5791L	Cl Syn 1 NH_2-N by S_1 eval.	9,760	37.77	12.92	750	760	1950	1170	8,060	82.4
5791O	Cl Syn 1 Imp. Ind. by S_1 eval.	9,430	36.34	12.94	810	670	2060	1210	7,730	81.8
Y517HO		9,160	35.25	12.99	640	620	2180	1080	7,680	83.7
Mean		10,360	38.00	13.64	1150	570	1940	1350	8,280	79.8
LSD (.05)		638	1.59	0.55	540	119	144	405	887	6.1
Coefficient of Variation (%)		6.2	4.2	4.0	47.6	21.1	7.5	30.3	10.8	7.7
F value		7.3**	8.5**	7.2**	3.4**	7.5**	10.6**	2.2**	3.1**	2.2**

1/ Cl Syn 1 populations were synthesized from remnant S_1 seed for S_1 and TC evaluations and from remnant FS seed for FS evaluations. For TC evaluations, 546H3 was used as the common tester. Selection intensity was approximately 10% for all traits and evaluation methods. GS and % S were selections for high performance. NH_2-N, Na, K, and Impurity index selections were made for lower values.

TEST 876-2. COMPARISON OF S_1, FULL-SIB, AND TEST-CROSS EVALUATION: HYBRIDS OF 791 WITH 546H3, SALINAS, CALIFORNIA, 1976

8 replications
2 row plots, 30 ft. long

Planted: February 3-4, 1976
Harvested: September 20-21, 1976

Variety	F70-546H3 x Cycle[1/]	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Amino N PPM	Na PPM	K PPM	Impur. Index	Recov. Sugar/A Pounds	Recov. Sugar Percent
US H10B		11,790	43.06	13.70	640	600	1700	930	10,140	86.0
5791HH8	x GS by FS eval.	11,730	42.67	13.74	660	610	1640	930	10,090	86.0
5791LH8	x NH_2-N by S_1 eval.	11,640	42.76	13.61	600	620	1560	890	10,090	86.7
5791BH8	x Mass sel. for YR	11,420	40.44	14.13	710	500	1610	920	9,860	86.3
5791FH8	x GS by S_1 eval.	11,340	42.34	13.38	600	680	1690	950	9,740	85.7
5791GH8	x GS by TC eval.	11,300	40.94	13.80	670	510	1660	920	9,740	86.2
5791JH8	x % S by TC eval.	11,270	40.86	13.79	720	550	1570	950	9,670	85.7
5791IH8	x % S by S_1 eval.	11,250	40.77	13.80	700	600	1550	950	9,660	85.8
5791NH8	x K by S_1 eval.	11,190	41.03	13.64	630	590	1430	870	9,730	86.9
3791H8	x unselected composite	11,150	40.92	13.63	670	620	1640	960	9,550	85.6
5791PH8	x Powd. Mildew sel.	11,090	40.34	13.74	830	560	1730	1070	9,320	84.0
5791MH8	x Na by S_1 eval.	10,960	40.12	13.66	740	520	1580	970	9,370	85.4
5743H8	x Monogerm selection	10,820	38.72	13.98	680	470	1650	900	9,370	86.5
5791KH8	x % S by FS eval.	10,770	39.30	13.71	700	570	1620	950	9,230	85.7
F70-546H3		10,700	38.52	13.89	630	610	1470	870	9,300	86.9
5791OH8	x Imp. Ind. by S_1 eval.	10,680	39.97	13.36	670	690	1600	980	9,120	85.2
Mean		11,190	40.80	13.72	680	580	1610	940	9,620	85.9
LSD (.05)		605	1.62	NS	118	130	120	NS	645	NS
Coefficient of Variation (%)		5.5	4.0	3.2	17.5	22.5	7.6	13.2	6.8	2.2
F value		2.6**	5.6**	NS	2.0*	1.8*	3.3**	NS	1.9*	NS

1/ At the same time that the remnant seed from the S_1 and FS families of the CO was being increased in isolation to produce the C1 Syn 1, it was also crossed to F70-546H3.

TEST 876-3. COMPARISON OF S_1, FULL-SIB, AND TEST-CROSS EVALUATION: HYBRIDS OF 791 WITH Y417HO, SALINAS, CALIFORNIA, 1976

8 replications
2 row plots, 30 ft. long

Planted: February 3-4, 1976
Harvested: September 21-23, 1976

Variety	Y417HO x Cycle 1/	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Amino N PPM	Na PPM	K PPM	Impur. Index	Recov. Sugar/A Pounds	Recov. Sugar Percent
5791NH37	x K by S_1 eval.	12,180	44.69	13.64	590	550	1540	860	10,610	87.1
5791HH37	x GS by FS eval.	12,130	45.43	13.34	640	550	1790	970	10,370	85.5
5743H37	x Monogerm selection	11,990	43.31	13.84	590	490	1620	850	10,470	87.3
5791BH37	x Mass sel. for YR	11,680	42.25	13.82	600	560	1760	900	10,110	86.5
5791FH37	x GS by S_1 eval.	11,650	44.23	13.17	540	630	1740	910	10,060	86.3
5791GH37	x GS by TC eval.	11,640	44.03	13.24	550	570	1700	890	10,080	86.6
517HL13	x COaa x C17	11,510	42.67	13.50	650	550	1600	930	9,920	86.0
5791PH37	x Powd. Mildew sel.	11,500	43.29	13.29	570	560	1840	930	9,910	86.1
US H10B		11,370	41.98	13.54	560	640	1500	860	9,910	87.1
5791IH37	x % S by S_1 eval.	11,200	41.83	13.39	590	650	1650	920	9,650	86.2
5791KH37	x % S by FS eval.	11,190	41.40	13.53	580	620	1580	880	9,710	86.8
5791JH37	x % S by TC eval.	11,170	41.53	13.44	630	570	1650	930	9,620	86.1
5791MH37	x Na by S_1 eval.	11,150	42.84	13.03	590	480	1710	920	9,610	86.2
5791OH37	x Imp. Ind. by S_1 eval.	11,030	40.94	13.48	520	640	1590	850	9,630	87.3
5791LH37	x NH_2-N by S_1 eval.	10,970	40.27	13.63	570	660	1400	850	9,580	87.2
Y517HO		9,640	36.47	13.24	460	570	1730	830	8,440	87.5
Mean		11,380	42.32	13.45	580	580	1650	890	9,860	86.6
LSD (.05)		637	1.93	0.64	71	104	133	NS	634	NS
Coefficient of Variation (%)		5.6	4.6	3.6	12.5	18.1	8.1	9.7	6.5	1.5
F value		6.9**	9.3**	1.7*	3.6**	2.1*	5.9**	NS	4.8**	NS

1/ At the same time that the remnant seed from the S_1 and FS families of the CO was being increased in isolation to produce the C1 Syn 1, it was also crossed to Y417HO. Y417HO = CMS equivalent of C17.

Performance of Sugarbeet Lines and Hybrids Selected for Resistance to *Erwinia*

R. T. Lewellen, E. D. Whitney, I. O. Skoyen

Since 1972, a series of selections for resistance to *Erwinia* have been made from field and greenhouse plantings. From C13, the pollinators of US H9, one, two, or three successive selections have been made. The seed increased from these selections have been coded with an "E" prefix, e.g., E506, E536, etc. More recently, selections for resistance also have been made from C17, the pollinator of US H10, and other self-sterile and self-fertile breeding lines. The results of field tests grown in 1976 to evaluate these selected lines and their hybrids are summarized below. Primarily, two lines (E506 and E536) selected from C13 and their hybrids have been compared to C17 and US H10B. E536 and E602 are being increased in 1977 and will probably be released in the fall of 1977 as *Erwinia* resistant breeding lines C36 and C02, respectively.

In addition to the comparisons summarized below, eight lines selected for *Erwinia* resistance and their hybrids were evaluated for performance in virus yellows inoculated and noninoculated tests. The results of these tests were presented previously in this report in Tables 1176-1 and 1176-2. Essentially these tests showed that the *Erwinia* resistant selections and their hybrids were equivalent to their corresponding nonselected checks. That is, C13 was not significantly different from E402 through E536 nor was US H9B different from E402H8 through E536H8. These tests did show that with natural infection, the selected lines were more resistant to *Erwinia* infection than C13 or C17.

The study to determine the inheritance of resistance to *Erwinia* was continued in 1976. The 1976 test data supported the hypothesis made from the 1975 data (see pages A75-80, 1975 Report, Sugarbeet Research) that resistance in lines C17 and C64 is primarily conditioned by one dominant, major gene with a background of modifiers and quantitative factors. The results of selection experiments helped substantiate this hypothesis. Rather dramatic increases in resistance were realized for the first two cycles of selection for resistance from C13, but continued improvement was relatively slow. Good technique to reduce the level of escapes was found necessary to make significant improvement.

YIELD EVALUATION TESTS, BRAWLEY, CA, 1976

Planted: September 10, 1975
Harvested: May 20, 1976

Hybrid[1]	Acre Yield		Sucrose	Bolting	Erwinia Rot[2]
	Sugar	Beets			
	Pounds	Tons	%	%	%
E536H8	9,190	36.5	12.6	9.5	0.5
E506H8	9,060	35.4	12.8	5.4	0.8
US H10B	8,550	33.8	12.7	5.8	7.6
LSD (.05)	510	1.4	0.5	3.2	--

Extracted from a test with 20 entries (B276).

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Pollinators

E536	8,060	30.1	13.4	6.8	0.4
E506	7,770	28.3	13.7	9.4	0.0
C17	8,050	29.7	13.5	2.7	20.0
LSD (.05)	580	2.1	0.4	2.0	--

Extracted from a test with 10 entries (B476-1).

1/ C17 is the pollinator of US H10B. E536 and E506 were used as the pollinators to produce E536H8 and E506H8, respectively. All three of these hybrids use 546H3 as the monogerm, seed bearing parent. Because E536 and E506 were selected for *Erwinia* resistance from C13, the pollinator of US H9, E536H8 and E506H8 should be nearly equivalent to US H9 type hybrids. E536 and E506 represent two successive selections for *Erwinia* resistance from C13.

2/ Due to natural infection. Counted at harvest.

YIELD EVALUATION TESTS, SALINAS, CA, 1976

Planted: November 13, 1975
Harvested: September 7, 1976

Hybrid	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose %	8/31 Bolting %
E536H8	10,560	36.9	14.3	19.9
E506H8	10,420	36.1	14.5	21.0
US H10B	9,840	34.7	14.2	18.2
LSD (.05)	660	2.8	0.7	6.8

Extracted from a test with 16 entries (576).

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Planted: January 7, 1976
Harvested: September 13, 1976

E536H8	10,630	40.4	13.2
E506H8	11,140	41.0	13.6
US H10B	10,780	40.3	13.4
LSD (.05)	660	1.9	0.6

Extracted from a test with 26 entries (776).

PASO ROBLES ERWINIA EVALUATION TEST, 1976

Union Sugar Co., Cooperator

Planted: March 1976
Harvested: October 29, 1976

Entry	Description	No. Roots	% Roots Healthy	DI[1/]
517	C17, pollinator of US H10B	56	37.5	48.6
517T	C17T, tetraploid of C17	169	16.6	73.8
US H10B	546H3[2/] x C17	263	81.7	12.8
E506H8	546H3 x E506	194	96.9	2.3
E536H8	546H3 x E536	221	97.3	1.5
517H29	536H72[3/] x C17	259	65.1	28.1
517TH29	536H72 x C17T	206	22.3	67.9
E506H29	536H72 x E506	231	96.5	2.0
E536H29	536H72 x E536	211	90.5	4.1
364H8	US H7A	258	96.1	1.9
Y501H29	536H72 x C01	243	87.2	10.4
523-5H31	718H3 x 417-1	271	82.2	11.4

These varieties were grown as single-bed plots (2-rows/bed, 50 ft long) in a commercial field of US H10B. The rot resulted from natural infection.

[1/] DI = Disease Index = A weighted average of the amount of rot. This value then approximately represents the percentage of root tissue for each entry that would be rotted.

[2/] 546H3 is moderately resistant to *Erwinia*.

[3/] 536H72 is moderately susceptible to *Erwinia*.

ERWINIA AND BOLTING EVALUATION, SALINAS, CA,

Entry	Description	Resistant Roots 1/	DI 1/	8/31 Bolting 2/
		%		%
417	C17, pollinator of US H10	27	41	10.0
813	C17	32	44	
F70-13	C13, pollinator of US H9	17	58	31.5
413C	C13	15	55	
E540	Erwinia Susc. Sel. C13	2	72	
E502	2 Erwinia Res. Sel. C13	85	6	14.7
E506	2 Erwinia Res. Sel. C13	90	4	16.9
E534	2 Erwinia Res. Sel. C13	65	8	7.6
E536	2 Erwinia Res. Sel. C13	100	0	13.5
E537	1 Erwinia Res. Sel. C17	56	32	7.6
E536	1 Erwinia Res. Sel. C13	59	30	12.1
E539	1 Erwinia Res. Sel. O13A	82	8	18.3
US H10A	569H3 x C17	46	21	
US H10B	546H3 x C17	50	17	6.6
E506H8	546H3 x E506	86	5	13.6
E536H8	546H3 x E536	93	2	15.7
E537H8	546H3 x E537	79	10	8.9
517H29	536H72 x C17	25	41	
E506H29	536H72 x E506	80	4	
E536H29	536H72 x E536	80	4	

1/ Data from a 2 replication test, 1-row plots 20 ft long. Planted May 6 and harvested October 10, 1976. On July 29, plants were injured and inoculated with mixed cultures of Erwinia.

2/ Data for bolting were from a 2 replication test, 1-row plots, 32 ft long. Planted November 12, 1975. Because seed lots tested were from increases made in different environments, definite conclusions on the nonbolting tendency of these lines and hybrids are not possible.

LATE PLANTED ERWINIA EVALUATION, SALINAS, CA, 1976

4 replications, RCB
1-row plots, 20 ft long

Planted: May 15, 1976
Injured-Inoculated: August 18, 1976
Harvested: October 22, 1976

Entry	Description	DI
417	C17, pollinator of US H10	51.2
623-5E	C23, 1 Erwinia Res. Sel. 417-1	48.0
F70-413	C13, pollinator of US H9	68.9
E540	Erwinia Susceptible Sel. C13	88.8
E502	2 Erwinia Res. Sel. C13	15.3
E602	C02, 3 Erwinia Res. Sel. C13	14.0
E506	2 Erwinia Res. Sel. C13	13.1
E606	3 Erwinia Res. Sel. C13	10.9
E534	2 Erwinia Res. Sel. C13	23.2
E634	3 Erwinia Res. Sel. C13	16.4
E536	C36, 2 Erwinia Res. Sel. C13	9.6
US H10B	546H3 x C17	40.6
E402H8	546H3 x E302	22.6
E602H8	546H3 x C02	12.7
E506H8	546H3 x E506	12.3
E606H8	546H3 x E606	15.7
E536H8	546H3 x C36	8.9
517H29	536H72 x C17	65.1
E506H29	536H72 x E506	36.2
E536H29	536H72 x C36	23.7
LSD (.05)		10.1

TEST 1676. EVALUATION OF BREEDING LINES AND HYBRIDS TO ERWINIA ROOT ROT, SALINAS, CALIFORNIA, 1976

2 replications
1-row plots, 20 ft. long

Planted: May 6, 1976
Inoculated: July 29, 1976
Harvested: October 7, 1976

Variety	Description	No. of Roots	% Resistant[1/]	DI[2/]
813	Inc. 713A (C17)	57	31.6	44.4
413C	Inc. 313 (C13)	54	14.8	54.7
E502	Inc. E402,-4,-5	53	84.9	5.8
E506	Inc. E406,...	60	90.0	3.7
E506H8	F70-546H3 x E406,...	63	85.7	5.3
E506H29	3536-97H72 x E406,...	59	79.7	4.4
E534	Inc. E434	51	64.6	7.6
E536	Inc. E402,5,6,34 (C36)	55	100.0	0.2
E536H8	F70-546H3 x E402,5,6,34	57	93.1	2.0
E536H29	3536-97H72 x E402,5,6,34	60	80.0	4.0
E537	ERS 813	50	56.0	31.8
E537H8	F70-546H3 x ERS 813	66	78.8	10.2
E538	ERS 413C	56	58.9	29.9
E539	ERS 013A	56	82.1	8.4
E540	ESS F70-413	57	1.8	72.4
417	Inc. 713A (C17)	62	27.4	41.0
117T	Inc. 917T (C17T)	62	8.1	69.7
F70-13	Inc. F66-413 (0268)	60	16.7	57.9
113T	Inc. 713T	45	8.9	69.4
417Tmm	Inc. 117Tmm	63	90.5	2.0
417H21	3536-97H0 x 813	69	42.0	25.6
517H72	3718H0B x 417	60	16.7	43.1
523-5A	Inc. 417-1	58	17.2	57.2
3213	BMRS 2216Bm- (C43)	52	25.0	41.2
5717	Inc. 4232	46	76.1	9.4
3204	Inc. Acc. 125	54	74.1	10.4
Y517	Inc. Y417 (C16)	51	33.3	38.2
Y517H0	Y417H0 x Y417 (C16H0)	55	45.5	26.9
Y417	Inc. Y317	36	22.2	41.4
Y417H0	Y317H2 x Y317	43	25.6	30.6
4247	BMRS 3209 (C32)	57	57.9	26.2
Y401A	YRS Y201 (C01)	61	62.3	20.3
Y422	YRS Y222A (C22)	57	29.8	42.6
Y523	Inc. Y423 (YRS US 15)	51	88.2	4.4
Y526	Inc. Y426 (YRS US 56/2)	56	85.7	5.1
464	Inc. F66-64 (C64)	52	92.3	2.4
468	Inc. 868 (US 75)	49	55.1	13.8
Y430	YRS Y230A,B (YRS US 75)	50	38.0	30.0
Y440	Inc. 3254 (C64 x C17)	57	68.4	9.7
Y441	Inc. 3255 (C64 x C01)	58	82.8	6.1

TEST 1676. EVALUATION OF BREEDING LINES AND HYBRIDS TO ERWINIA ROOT ROT, SALINAS, CALIFORNIA, 1976 cont.

Variety	Description	No. of Roots	% Resistant[1/]	DI[2/]
Y442	Inc. 3256 (C64 x C04)	55	67.3	10.7
Y331	Inc. Y231 (C31)	60	58.3	17.0
US H10A	Lot 1231 569H3 x C17	59	45.8	20.6
US H10B	Lot 1068 546H3 x C17	62	50.0	16.9
517H17	8551H4 x 417	67	22.4	33.2
517TH17	8551H4 x 117T	64	20.3	40.0
517H29	3536-97H72 x 417	32	25.0	41.3
517TH29	3536-97H72 x 117T	32	21.9	45.0
517H36	3536-97H23 x 417	63	33.3	29.9
517TH36	3536-97H23 x 117T	68	14.7	44.5
F66-562H0	562H0 x 562 (6349)	67	52.2	21.0
F66-563H0	563H0 x 563 (6486)	59	49.2	21.6
5564	Inc. 4564C1	69	26.1	32.3
F70-546	Inc. F63-546 (0139)	59	79.7	6.6
5551	Inc. 8551	51	60.8	14.3
F66-569	Inc. F59-569 (6616)	52	84.6	3.2
3522-25	Inc. 1522-25	43	25.6	50.2
5522-29	Inc. 4522-29	65	40.0	30.8
4536-97	Inc. 3536-97	62	29.0	27.8
F71-705	Inc. C0705	52	25.0	36.2
3705	Inc. 2705 (C706)	61	32.8	34.5
F74-718	Inc. C2718	65	33.9	34.1
F74-718H0	C2718H0 x C2718	66	47.0	22.9
3718	Inc. 2718 (C718)	64	34.4	38.5
3718H0B	2718H0 x 2718 (C718H0)	71	26.8	28.5
3536-97H3	F66-562H0 x 8536-97	66	45.5	16.7
3536-97H72	2718H0 x 8536-97	63	39.7	20.9
5536-97RH22	1522-25H0 x 4536-97R	62	32.3	30.0
2522-29H23	0522H52 x 8522-29C2	45	24.4	44.6
5522-29H21	3536-97H0 x 4522-29	49	32.7	34.0
5551H5	F67-564H0 x 8551	59	55.9	6.9
5551H17	8551H4 x 8551	48	45.8	12.6
5551H21	3536-97H0 x 8551	62	59.7	8.8
4547H1	1502H0 x 2547 (NB1 x NB5)	57	63.2	8.0
4554H1	1502H0 x 0554 (NB1 x NB4)	68	55.9	16.1
4554H4	3536H0 x 2554	59	18.6	44.6
5564H1	4124,7 x 4564C1	56	33.9	24.4
F70-546H3	562H0 x F63-546 (0036)	64	79.7	5.0
3546H72B	2718H0 x F70-546	61	67.2	14.3
3546H54	2705H0 x F70-546	71	80.3	4.7

TEST 1676. EVALUATION OF BREEDING LINES AND HYBRIDS TO ERWINIA ROOT ROT, SALINAS, CALIFORNIA, 1976 cont.

Variety	Description	No. of Roots	% Resistant[1/]	DI[2/]
3718H3	F66-562H0 x 2718	63	63.5	15.9
3718H4	F66-563H0 x 2718	73	58.9	16.9
3718H5	F68-564H0 x 2718	72	48.6	24.3
3718H54	2705H0 x 2718	70	42.9	24.9
F67-569H3	562H0 x 569 (7228)	116	62.1	12.7
F69-546H3	562H0 x 546 (9029)	123	66.7	9.8
F69-546H4	563H0 x 546 (9056)	127	73.2	3.9
F69-546H5	564H0 x 546 (9028)	119	58.0	8.6
5701	Inc. 3601-5C1	44	34.1	33.8
5702A	Inc. 3798-1,2,4,5,6	61	0.0	63.3
5703A	Inc. 3793-5,10,11	66	54.6	19.7
5744A	YRS 3789	52	55.8	15.5
5745A	YRS 3790	64	57.8	19.4
5755BA	YRS 3755	70	64.3	16.0
5778	Inc. 3778-10,17	57	68.4	9.3
5779	Inc. 3779-7,16,17	66	63.6	14.9
5780	Inc. 3780-4,6,7,11	70	12.9	70.9
5788	Inc. 4788	65	69.2	8.4
5796-1	Inc. 4796-1	62	40.3	27.1
4775A	YRS 2775C1A	63	63.5	9.9
4776A	YRS 2776C1A	56	85.7	6.0
4777A	YRS 2777C1A	48	64.6	19.0
4792A	YRS 2792A	63	39.7	29.9
4793A	YRS 2793A	63	77.8	4.5
4794A	YRS 2794A	71	69.0	7.8
4795A	YRS 2795A	65	56.9	17.0
4797A	YRS 2797A	64	70.3	14.5
4798A	YRS 2798A	68	19.1	54.0
3761-3	YRS 1761-3C1	63	19.1	46.4
3770	2770Bmm⊗	53	77.4	11.9
3771	2771Bmm⊗	64	76.6	8.8
3774	2774Bmm⊗	52	53.9	20.9
2730	1730mm⊗	54	20.4	62.9
2731	1731mm⊗	65	43.1	35.6
2736	1736mm⊗	60	75.0	9.4
2737	1737mm⊗	59	62.7	11.5
2758-1	YRS 0758-1C1mm	50	14.0	52.8
2758-3	YRS 0758-3C1mm	64	39.1	37.5
5740	4740aa x A	65	46.2	19.3
5741	4741aa x A	62	40.3	17.0

TEST 1676. EVALUATION OF BREEDING LINES AND HYBRIDS TO ERWINIA ROOT ROT, SALINAS, CALIFORNIA, 1976 cont.

Variety	Description	No. of Roots	% Resistant 1/	DI 2/
5742	3791(T-O)Claa x A	60	60.0	12.5
5743	3791Claa x A	62	58.1	11.2
5755	4755Baa x A	64	23.4	31.7
5756	4755aa x YR,MM,S^f	63	25.4	34.2
5791I	3791-HS(S_1)aa x A	64	48.4	17.0
4789	3789aa x A (C789)	58	53.5	17.2
4790	3790aa x A	59	52.5	21.4
3773	1773a-HSA x aa (C773)	55	67.3	16.0

1/ % resistant = number with 0, VN x 100/total.

2/ DI = Disease Index = Σ% rot/no. of roots. Roots scored on a scale of 0, 1 (VN), 7, 25, 50, 75, 93, and 100% rot.

PERFORMANCE OF NEMATODE WILTING TOLERANT SELECTION, SALINAS, CALIFORNIA

Under High Nematode Infestation

10 replications — Planted: April 21, 1976
1 row plots, 20 feet long — Harvested: October 13, 1976

Variety[1]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Wilting[2]	Harvest Count[3]
	Pounds	Tons	Percent	Grade	Number
880	5,086	21.66	11.7	3.0	143
US H10	2,071	8.88	11.6	6.3	127
Mean	3,578	15.27	11.7	4.7	Beets
LSD (.05)	655	0.75	NS	0.8	per
CV (%)	18.1	152.7	7.2	17.6	100'
F value	108.4**	169.2**	0.10	82.1**	row

Under Moderate Nematode Infestation

10 replications — Planted: April 21, 1976
1 row plots, 20 feet long — Harvested: October 13, 1976

Variety	Acre Yield Sugar	Acre Yield Beets	Sucrose	Wilting	Harvest Count
	Pounds	Tons	Percent	Grade	Number
880	6,449	25.74	12.5	3.9	133
US H10	4,704	19.58	12.0	4.9	150
Mean	5,576	22.66	12.3	4.4	Beets
LSD (.05)	940	5.07	0.45	0.5	per
CV (%)	16.7	15.7	3.7	10.7	100'
F value	17.65**	15.05**	7.47*	22.7**	row

Under Nematode Free Conditions

10 replications — Planted: March 16, 1976
2 row plots, 53 feet long — Harvested: October 15, 1976

Variety	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot	Harvest Count
	Pounds	Tons	Percent	Percent	Number
880	9,020	34.10	13.2	10.8	115
US H10	10,790	39.48	13.7	2.7	138
Mean	9,905	36.79	13.5	6.8	Beets
LSD (.05)	577	1.77	0.4	1.4	per
CV (%)	6.1	5.2	3.3	57.7	100'
F value	8.70**	12.65**	6.18**	38.27**	row

**Exceeds the 1% point of significance.
*Exceeds the 5% point of significance.

1/ Variety 880 selected by the Instituut voor Rationele Suikerproductie in the Netherlands for tolerance to wilting caused by the sugarbeet nematode. US H10 is an unselected check.

2/ 1 = No wilting, 10 = Severe wilting.

3/ Yield adjustments made for stand gaps of 2 feet or more.

FUSARIUM STALK BLIGHT RESISTANCE TEST
Salem, Oregon, 1975-76
Cooperative with West Coast Beet Seed Company

4 replications
1 row plots, 50 ft. long

Planted: August 25, 1975
Rated: August 13, 1976

Entry	Description	Grade 1/
4554H1	NB 1 (CMS) x NB 4	0.16
5505C1	F_2(2563aa x 1502)	0.34
1502H0	NB 1 (CMS)	0.39
1502	NB 1	0.41
5106Aa	502aa x 564	1.04
5105	(563aa x 502Aa) x (561aa x 536-97)	1.07
5564H1	(502H0 x 562) x 564	1.42
5506C2	F_2(2502aa x 1565)	1.45
US H10	Commercial variety	1.83
5522-29H21	536-97H0 x 522-29	2.07
F67-563	563 inbred	2.48
5551H37	536-97H0 x 551	2.57
5551H5	564H0 x 551	3.07
3565	565 inbred	3.59
5564	564 inbred	3.86
Mean		1.72
LSD (.05)		0.40
Coefficient of Variation (%)		16.43
F value		72.59**

**Exceeds the 1% point of significance (F = 2.54).

Single row - 50 ft. long

2554 (Iso.)	NB 4 inbred	0.04
4554H4	3565H0 x 2554 (Iso.)	0.06
5104Aa	2563aa x 4502-1	0.44
5522-29	Inc. 4522-29	2.19
5551	Inc. 8551	2.98
4536-97	Inc. 3536-97	3.27

1/ Stalk blight rated on a scale of 0 to 4 with 0 = no disease and 4 = dead plant.

Yield Compensation in Sugarbeet Infected with Different Levels of Severe Beet Curly Top Virus

I. O. Skoyen and J. E. Duffus

Strains of beet curly top virus capable of causing substantial damage on resistant cultivars of sugarbeet have increased in number and distribution in "curly top areas" over the last 15 to 20 years. However, the extent of and the implications of the actual damage and yield losses caused by infection with these more severe isolates has not been fully investigated.

Since naturally occurring beet curly top infection probably seldom reaches levels of 100%, the present study was designed to evaluate the relationship of inoculated and healthy plants where different percentages of plants became infected at different stages in the growth cycle. The main objective of the test was to determine the compensation on yield by healthy plants growing among diseased neighbors and because of the compensatory effect, what level of beet curly top virus could be tolerated without causing serious reductions in yield.

MATERIALS AND METHODS--The sugarbeet cultivar US 75, which possesses good resistance to curly top, was seeded May 22, 1976 in a split-plot design with 5 replications at the U.S. Agricultural Research Station, Salinas, California. The main plots were two dates of inoculation, June 24 (early) and July 22, 1976 (late), four weeks and eight weeks after seeding. The sub-plots were five levels of curly top virus inoculation--16.7, 33.3, 66.7, 100.0% and an uninoculated control treatment. Main plots were randomized within blocks and sub-plots were completely randomized within main plots. Plants to be inoculated were evenly and randomly assigned among sub-plot rows. Sub-plot size was four rows, 16.5 feet long. Stands were thinned to 60 plants per plot prior to the first inoculation.

A severe isolate of the curly top virus (Logan) collected from Utah and as virulent as any isolate previously tested in California was used in the inoculation.

Inoculations were made by attaching two small leaf cages containing three leafhoppers reared on virus infected plants to the youngest leaves of the plants. The cages were made from 25mm diameter acrylic tubing covered at each end by nylon material and held tight to the leaf surface with bent hair clips. Cages remained on the inoculated plants for 1 week. Insect survival was over 90% during these inoculation periods. The plants were examined at weekly intervals for curly top symptoms until harvest, November 11, 1976, when the plants were 24 weeks old.

RESULTS--<u>Percent infection</u>--As has been established in previous experiments (Sugarbeet Research Report - 1970, 1973, and 1975), the inoculation technique used resulted in high curly top virus infection under field conditions (Table 1). In the 1976 test, the inoculation of young plants, four weeks after seeding, resulted in about 100% infection of the inoculated plants. In plants inoculated eight weeks after seeding, infection percentages (as measured by visible symptoms) averaged 64% of inoculation.

Table 1. Effects of a severe isolate of the beet curly top virus on a resistant sugarbeet cultivar inoculated with different percentages of virus and at different intervals after seeding.

Date (D) Inoculated		Percent Curly Top (P) 0	16.7	33.3	66.7	100	Mean
		Observed Curly Top Infection (%)					
6/24/76		0.7	16.7	34.7	66.9	99.1	
7/22/76		0.7	12.3	20.5	43.3	57.4	
		Roots (Tons/Acre)					
6/24/76		31.5	31.5	28.1	20.3	3.5	23.0
7/22/76		32.4	30.6	31.2	31.0	30.2	31.1
	Mean	31.9	31.1	29.7	25.7	16.8	
		Sucrose (%)					
6/24/76		13.06	13.08	12.64	11.95	9.52	12.05
7/22/76		12.72	12.85	12.88	12.70	12.57	12.74
	Mean	12.89	12.97	12.76	12.33	11.05	
		Gross Sugar (lbs/Acre)					
6/24/76		8,211	8,193	7,129	4,841	671	5,809
7/22/76		8,228	7,844	8,043	7,884	7,573	7,914
	Mean	8,220	8,019	7,586	6,362	4,122	
		Weeks After Inoculation to Maximum No. Plants Showing Symptoms					
6/24/76			3.0	4.0	4.8	4.8	4.1
7/22/76			8.2	7.6	10.2	10.8	9.2
	Mean		5.6	5.8	7.5	7.8	

	Roots T/A	Sucrose %	Gross Sugar lbs	Max. Symptoms Weeks
LSD 5% for inoc. date (D) means	2.3	0.37	638	2.8
" % CT (P) means	1.9	0.49	538	1.5
" P for diff. D	3.3	0.72	922	3.2
" P x D interaction	2.7	0.70	760	2.1

The 1976 data, which substantiate earlier results, show that a significant increase of resistance to infection occurs as the plants increase in size and/or age and that this phenomenon may occur early in plant development.

Root yield--For the early curly top (CT) virus inoculation, significant yield losses of 11, 36 and 89% occurred for the 33.3, 66.7 and 100% CT treatments, respectively (Table 1). There was no difference in yield between the control and the 16.7% CT treatment. A significant yield loss occurred only for the 100% CT treatment for the later inoculation date, but it was still 93% of the control.

The percentage proportion diseased plants contributed to total yield for both inoculation dates is shown in Table 2. The catastrophic effect on root yield of curly top infection in young plants is clearly evident. Healthy plants through compensation, however, accounted for 98, 96 and 89% of the root yield for the 16.7, 33.3 and 66.7% CT treatments, respectively. Yields of healthy plants (no visible symptoms) for the late inoculation ranged from 90% with 12% of the plants of the 16.7% CT treatment showing symptoms to 45% with 57% of the 100% CT treatment showing symptoms.

A comparison of the average root weight of healthy vs. CT infected plants (Table 2) shows that as the number of diseased plants increased, root weight of healthy plants increased in compensation for diseased neighbors. Plants infected early had a mean root weight of 0.43 lbs., or 8% of the mean root weight of healthy plants. Root weight of healthy plants in the later CT inoculation (8 weeks after seeding) was essentially the same over all CT treatments with a mean of 4.3 lbs. Diseased plants, however, had a mean root weight of 3.5 lbs. or 81% of that of healthy plants. Diseased plants tended to have higher average root weights as % CT increased indicating that better growth occurred when they competed with fewer healthy plants.

Sucrose--Sucrose content of the early inoculated 16.7 and 33.3% CT treatments was no different from that of the control but the 66.7 and 100% CT treatments were significantly lower. The 100% CT treatment had a sucrose content loss of 28%. Separate sucrose content determinations were made for the healthy (no visible symptoms) and diseased proportions for each inoculated plot and a weighted average sucrose percentage calculated for use in data analyses. For the late inoculation date, there were no differences in sucrose content between the control and CT treatments.

Gross sugar--The effect curly top virus has on root yield and sucrose percentages is reflected in the gross sugar values (Table 1). The early inoculation caused significant reductions in gross sugar for the 33.3, 66.7 and 100% CT treatments; however, the late inoculations caused a significant loss only in the 100% CT treatment. Gross sugar production for the 100% CT treatment was 8% and 92% of the control for the early and late inoculation dates, respectively.

Incubation period--The maximum expression of curly top symptoms (number of plants per plot) consistently occurred within a shorter time for the 16.7 and 33.3% CT treatments for both inoculation dates than that for the 66.7 and 100% CT treatments, although this was not significant (Table 1). The mean time period for maximum expression for the early

Table 2. Comparison of root weight and acre yield of a resistant sugarbeet cultivar inoculated at different percentages and intervals after seeding with a severe isolate of beet curly top virus.

Date Inoculated	Percent Curly Top 0	16.7	33.3	66.7	100.0	Mean
	Root Yield (Tons/Acre					
6/24/76						
Healthy	31.5	31.0	27.0	18.1	--	26.4
Diseased	--	0.5	1.2	2.2	3.5	1.9
Total	31.5	31.5	28.2	20.3	3.5	28.2
Contribution of diseased as a % of total yield	0	1.6	4.3	10.8	100.0	
7/22/76						
Healthy	32.4	27.6	26.2	19.2	13.7	23.8
Diseased	--	3.0	5.1	11.8	16.4	9.1
Total	32.4	30.6	31.3	31.0	30.1	31.1
Contribution of diseased as a % of total yield	0	9.8	16.3	38.0	54.5	29.6
	Average Single Root Weight (lbs)					
6/24/76						
Healthy	4.21	4.72	5.33	7.12	--	5.34
Diseased	--	0.37	0.45	0.42	0.48	0.43
Diseased root wt. as a % of healthy wt.	--	7.8	8.4	5.9	--	8.0
7/22/76						
Healthy	4.33	4.15	4.36	4.44	4.14	4.28
Diseased	--	3.19	3.26	3.59	3.84	3.47
Diseased root wt. as a % of healthy wt.	--	74	75	81	93	81

inoculation was 4 weeks whereas for the late inoculation, this was 9 weeks. This is an important attribute of curly top resistance and substantiates 1975 test results that increasing incubation periods for later inoculation dates are probably the most important factor in disease resistance and minimizing damage from infection.

DISCUSSION--The prevention of severe curly top virus infection during the early period of sugarbeet growth, probably for about 8 weeks after seeding, is an important factor in reducing yield losses in areas where the disease is prevalent, particularly since present day virus isolates are generally more virulent than those of 20 years ago. The period of high susceptibility may be shorter in warmer areas where faster growth occurs. In instances where infection occurs when plants are about a month old, the present study indicates that little yield loss may result if only about 20-25% of the plants are infected. At this level, healthy plants tend to compensate completely for diseased neighbors. Slightly higher early infection percentages might be tolerated with longer growing seasons because of greater compensatory growth by healthy plants. Even when infection occurs later and both resistances to infection and to damage are functioning, growth compensation by healthy plants is important to total yield. Observations in a 1975 test that the length of time diseased plants showed symptoms before harvest was highly correlated with yield losses was also shown in this test where diseased plants inoculated 8 weeks after seeding had a mean root weight 20% lower than that of healthy plants (no CT symptoms observed).

Both the 1975 and 1976 tests indicated that the longer the incubation period after inoculation, before curly top symptoms developed, the less damage or yield loss occurred. It appears, from observations of the two tests, that little or no damage from curly top virus occurs until after visible symptoms have developed.

CONTENTS

I. EXPERIMENTAL FIELD TRIALS

J. Clair Theurer and Devon L. Doney

A. Agronomic Data

1. Soil Types: North Farm - Silty loam
   Farmington Farm - Sandy loam

2. Fertilizer: North Farm - 500 lbs./acre of 24-20-0
   Farmington Farm - 580 lbs./acre of 24-20-0

3. Planting Dates: North Farm - May 5 and 6
   Farmington Farm - April 21

4. Thinning Dates: North Farm - June 7-11
   Farmington Farm - May 20-25

5. Irrigations: North Farm - Sprinkler irrigated twice before thinning and at weekly intervals after thinning.

   Farmington Farm - Furrow irrigated at weekly intervals after thinning.

6. Harvest Dates: North Farm - October 18-21
   Farmington Farm - October 5-7

7. Harvesting Procedures: Tops were removed by beating twice with a rotobeater, then topped and dug with a two-row harvester. Beets/plot were counted as they went into a weighing basket on the harvester. Two 10-beet samples were taken at random from each 2-row plot for sugar analysis. All beets in each plot were weighed to determine root yield.

B. Selection for Root/Top Ratio

In 1974 a series of open-pollinated, highly heterozygous lines were grown in a space planted (0.6 M) nursery. At harvest time, each plant was cone trimmed and the top and root weights taken. The root/top ratio calculated from this data for each plant was used as a selection criterion. The populations were further categorized into three groups based on this specific gravity with Group #1 = high specific gravity, Group #2 = medium specific gravity, and Group #3 = low specific gravity. Plants with a specific gravity of #2 or better and a root/top ratio of >1.9 were placed in Selection Population 1. Plants with a specific gravity of #2 or better and a root/top ration of <1.9 were placed in Selection Population 2.

In 1975, the two selection populations were grown in separate isolation plots and allowed to interpollinate within each population. Seed was harvested from individual plants. Those plants producing sufficient seed were tested in a replicated field trial in 1976 (Sel. Pop. 1 = Table B1, Sel. Pop. 2 = Table B2). Four check varieties (GWD2, AH10, U&I8 and US22/3) were randomized in both tests. Harvest and impurity data are given in Tables B1 and B2. There was a good range in yield in both tests. The check varieties fell in about the same place in both tests (Tables B1 and B2). Population 1 (Table B1) was a little higher in yield than Population 2 (Table B2); however, they were grown at different locations in the field.

The comparison between the check varieties and selections is shown in Table B3. The relationships were about the same in each test. The selections yielded a little less than the check varieties in Population 2, but it wasn't significant.

The selection for root-top ratio of the mother beets appeared to have little influence on the progeny root yield. Correlations between progeny root yield and mother beet root/top ratio were also non-significant.

C. Selection in 2N vs 4N

Over the past several years, two heterozygous populations have been built from the same genetic material. The only difference between the two populations is that one is 2N, and the other is the 4N complement.

Our objectives in developing these two populations is to 1) determine the effectiveness of selection in a 2N vs 4N population and 2) determine in which population selection is most effective for the production of 4N x 4N, 4N x 2N, 2N x 4N, and 2N x 2N hybrids.

In 1974, these two populations were planted in a space-planted (61m) nursery. Beets were selected, based on appearance only. Selected roots were planted in an open-pollinated seed isolation plot for each population respectively. Seed was harvested on each plant separately.

Those plants producing sufficient seed were tested in a replicate field trial in 1976 (Table C1 = 2N and Table C2 = 4N).

Four commercial hybrids were randomized in each test to serve as checks. In both the 2N (Table C1) and 4N (Table C2) test, one

or more lines equaled the highest yielding commercial hybrid (GWD2) in root weight; however, their sugar percentage was low. These lines, on a whole, were high yielding but low in sugar percentage.

The selections mean root yield was significantly larger than the check varieties mean root yield for both the 2N and 4N populations (Table C3). However, the sugar percentage of the selections was less than the check varieties for both populations (Table C3).

This comparison between the selections and the check varieties was more pronounced in the 4N populations: i.e., the increase in root yield and decrease in percent sugar compared to the check varieties were greater in the 4N population than the 2N population. However, the two populations appear to be fairly similar at this stage of selection.

We will make further selections for combining ability and test the effectiveness of selection in 4N x 4N, 4N x 2N, 2N x 4N, and 2N x 2N hybrid combinations.

D. Commercial Variety Comparison

Eleven current commercial varieties, nine experimental hybrids and the old check variety US22/3 were evaluated for yield and sugar content at two locations, Logan and Farmington, Utah. Three entries, Marimono, Monova and Ultramono, are European triploid hybrids. Six replicates of two-row plots 38 feet long were grown at each location.

At Logan, HH22, GWD2 and two European triploid varieties yielded over 20 tons per acre (Table D-1). Hybrids with L19 parentage were highest in sugar percentage. One Europen triploid, Ultramono, was equal to the L19 hybrids for this character (16.1% sugar). Nine varieties were significantly superior in gross sugar than the old open-pollinated variety US22/3.

The performance of the varieties at Farmington is listed in Table D-2. Highly significant differences were observed for the entries between the two locations. At Farmington, we experienced quite severe curly top which is reflected in the beet yield. Triploid varieties from Europe, which yielded high at Logan, were the lowest in gross sugar. This, no doubt, was due to the curly top infection at Farmington. GWD2 and HH22 were lower in yield at this location than they were in 1975 (see page B16 of 1975 Research Report). L37 hybrids had the highest yield at Farmington and again L19 hybrids were highest in sugar percentage. Ultramono failed to show the sugar content at Farmington that was observed at Logan.

E. Evaluation of Combining Ability of Russian Diploid Varieties by Top Cross Tests.

Variety Test 4 was a top-cross test consisting of eight Russian varieties which were crossed as male parents to seven U.S. CMS inbreds to obtain an indication of the genetic diversity of the Russian material. In addition, four commercial varieties and US22/3 were included in the tests as checks. Plots were two rows 40 feet long and replicated six times at the Greenville farm in Logan.

Crosses with 649 and 650 in general showed the poorest vigor and top growth development. In general, crosses made to L28 exhibited large, vigorous, erect canopies.

Yield, sugar percent, and impurity data are given in Table 4. GWD2 check was the highest yielding variety in the test. Several top crosses significantly outyielded the other check varieties, and all but 12 of them were significantly better than US22/3.

Analysis of variance and means for combining ability for the Russian variety top crosses for gross sugar, root weight, and sugar percent are shown in Tables E-2, E-3, and E-4.

Both males and females showed significant differences in general combining ability for the three variables. Specific combining ability was noted only for sugar percent (Table E-4). Russian variety 645 showed the greatest general combining ability for root yield (Table E-3). The 638 variety showed the best combining ability for sugar percentage (Table E-4). L9 had the greatest combining ability of the inbreds for root weight, but also was the line showing the poorest combining ability for sugar percent when associated with the Russian material. C3 gave similar response to that observed for L9. A5 showed the best combining ability of the female parents for sugar percentage.

F. Sugar Percentage of Polish Varieties.

According to European breeders, Polish varieties have high sugar content. This test was designed to evaluate several miscellaneous Polish seedlots that we had in storage that were not known to have merit for other characteristics. These were planted in three replicates of two-row plots 20 feet long with two rows of a buffer variety between each entry. L8, L19, C17, and D2 were used as checks.

Results

None of the varieties had sugar percentages equal to L19,(Table F-1). P poly, Aj Poly 2, and Poly 2 were best for sugar content. Of note was the fact that the entries having the highest sugar were also

the best yield entries. Two entries were better than D2 for sugar percent, but D2 was significantly higher in root weight than any of the entries tested.

G. A Comparison of Three Methods of Selection for Sugar Percentage of Individual Beets.

In 1975, two populations, 7225-1 and 7225-2, were grown in strips in the field. Plants were spaced approximately 15 inches apart. At harvest, each individual root was classified for its relative specific gravity by placing the roots in two salt solutions. Solution #1 had a specific gravity of 1.066, Solution #2 of 1.056, and #3's were those beets that floated in the #2 tank. Selections of roots were made from each population for high and low specific gravity. The beets were plugged using Stout's method, then cut in half. One half was shredded with a vegetable shredder, and the other half was saved for seed increase. Twenty beets were selected on the basis of their polarimeter reading for each of the shred and plug methods. Alternate choices were made so as to distribute beets that would be selected by both methods as highest in sugar in an unbiased manner. The residual high (#1) and low (#3) specific gravity selections from each population that were evaluated in the laboratory were also retained to represent a selection for sugar by specific gravity only. Thus, eight populations as described in Table G-1 were formed. After the half beets were induced for eight weeks, they were placed in groups in isolation chambers for seed production. Since the S^f gene was in both populations, the seed harvested from these plots would be predominantly selfed seed.

The 12 selected populations and the two original parents, 7225-1 and 7225-3, were planted in two-row plots 40 feet long at the Evans farm near Logan. The experiment was harvested September 22, 1976, and sugar percent was determined.

Results

A comparison of the three individual beet selection methods for sugar percentage is shown in Table G-1. There was a significant difference between the high and low selections by each method.

All three methods were equally effective for selection. The specific gravity method has the advantage that it is an easy procedure and requires less time than the other two methods.

Table B-1. Selections >1.9 root/top ratios - root yield, percent sugar and impurity factors.

	Acre Yield			PPM			
Description	Gross Sugar	Tons Beets	Percent Sugar	Index	N	Na	K
GWD2	8290	27.5	15.1	486	374	106	1289
f680	7613	24.8	15.4	505	338	161	1520
f682	7522	24.7	15.2	542	344	217	1604
f670	7429	26.5	14.1	591	331	193	1725
f676	7293	23.6	15.5	555	402	229	1497
f667	7271	24.7	14.7	530	348	232	1387
AH 10	7224	24.8	14.6	529	375	110	1420
f685	7094	23.9	14.9	516	298	195	1579
f683	6987	24.0	14.6	561	343	203	1610
f669	6959	24.0	14.5	595	388	197	1614
f678	6958	24.4	14.3	633	362	210	1864
f684	6955	23.7	14.7	535	318	216	1566
f660	6953	24.1	14.4	548	324	170	1631
f679	6415	22.9	14.0	589	337	196	1672
f682	6384	21.7	14.7	553	323	216	1650
U&I 8	6279	21.6	14.6	488	357	151	1202
f684	6233	21.9	14.3	647	394	177	1839
f666	6384	21.7	14.1	578	325	227	1635
US22/3	5739	19.5	14.7	531	375	146	1410
f662	5699	19.9	14.3	594	355	134	1779
f672	5538	19.7	14.0	591	331	193	1725
Mean	6812	23.3	14.6	561	353	188	1580
LSD	752	2.5	0.7	89	76	54	196
C. V. Percent	9.7%	9.5%	4.3%	13.9	18.8	25.1	10.8
Calculated F	6.88**	5.33**	2.8**	2.2**	1.2	4.5**	5.8**

** - Significant at p = .01

Table B-2. Selections <1.9 root/top ratio - root yield, percent sugar, and impurity factors.

	Acre Yield			PPM			
Description	Gross Sugar (Lbs.)	Tons Beets	Percent Sugar	Index	N	Na	K
GWD2	7911	26.8	14.7	584	452	115	1464
f735	7294	24.3	15.0	527	331	169	1585
f706	7072	24.4	14.5	580	360	216	1612
f709	6993	23.5	14.9	532	330	230	1514
f692	6940	24.8	14.0	635	402	155	1693
f688	6883	24.0	14.3	617	416	244	1508
AH #10	6839	23.6	14.5	537	375	116	1437
F713	6722	23.5	14.3	619	366	256	1702
f729	6640	22.9	14.5	552	378	241	1350
f718	6624	22.6	14.7	534	350	209	1427
f693	6598	22.6	14.6	503	282	213	1508
f694	6582	23.7	13.9	602	328	217	1729
f712	6557	22.3	14.6	531	334	201	1477
f730	6417	22.6	14.3	577	350	249	1508
f698	6378	22.6	14.2	611	378	258	1572
f690	6373	21.6	14.8	551	375	197	1439
f724	6371	22.9	13.9	736	458	235	1922
f696	6175	22.1	14.0	572	358	198	1468
f728	6173	21.5	14.3	544	310	266	1497
U&I #8	6128	20.9	14.7	505	368	189	1206
f726	6119	20.7	14.8	526	316	240	1477
f705	5999	21.5	13.9	614	392	301	1431
f689	5873	20.6	14.3	572	362	222	1500
f710	5755	19.7	14.6	598	394	231	1564
f702	5504	19.8	13.9	636	372	313	1589
US22/3	5423	18.7	14.5	524	379	176	1277
f719	5136	18.6	13.8	648	415	206	1618
f717	3991	13.9	14.4	521	334	228	1333
Mean	6338	22.0	14.4	575	367	218	1515
LSD	671	2.2	0.7	83	70	53	201
C.V. %	9.4	8.7	4.7	12.7	16.8	21.6	11.8
F	9.5**	9.9**	1.9**	3.1**	2.5**	5.6**	3.9**

** - Significant at $p = .01$

Table B-3. Comparison for percent sugar and root yield between check varieties and selections with root/top ratio > 1.9 and root/top ratio < 1.9.

Description	Test 8 (R/T > 1.9) Percent Sugar	Root Yield Tons/Acre	Test 9 (R/T < 1.9) Percent Sugar	Root Yield Tons/Acre
Check Varieties	14.75	23.35	14.57	22.50
Selection Mean	14.60	23.30	14.40	22.00
t .05	0.30	0.91	0.26	0.87

Table C-1. Yield and impurity data for 2n selections and four hybrid check varieties.

Description	Acre Yield: Gross Sugar (Lbs.)	Acre Yield: Tons Beets	Percent Sugar	PPM: Index	PPM: N	PPM: Na	PPM: K
GWD2	8691	29.8	14.6	560	401	138	1439
f341(d42-252)	8658	30.6	14.2	554	296	148	1733
f331A(d42-65)	8551	30.7	14.0	565	317	151	1658
f344(d42-327)	8369	28.9	14.5	499	287	158	1512
f336(d42-137)	8195	29.5	13.9	621	320	173	1908
f343A(d42-303)	7968	28.2	14.2	534	285	165	1637
f329(d42-52)	7947	28.9	13.8	555	298	146	1627
f333(d42-95)	7906	27.9	14.2	561	311	170	1689
f339(d42-241)	7871	28.3	13.9	584	315	180	1716
f351(d43-173)	7822	27.8	14.1	571	296	201	1737
f322(d41-226)	7813	29.0	13.5	560	291	274	1462
f337(d42-146)	7763	27.1	14.3	618	386	160	1762
f325(d42-26)	7742	27.4	14.1	539	320	158	1502
f338(d42-217)	7739	28.2	13.8	538	276	163	1610
f343(d42-322)	7676	27.7	13.9	619	372	156	1720
f327(d42-49)	7644	28.0	13.6	544	274	177	1591
f350(d43-157)	7634	27.4	13.9	591	333	232	1612
f331B(d42-79)	7602	27.1	14.0	635	378	132	1833
f326(d42-38)	7561	26.6	14.3	560	333	165	1604
f334(d42-105)	7518	27.2	13.8	614	353	222	1650
AH #10	7234	25.8	14.1	554	371	150	1406
f342(d42-291)	7224	26.6	13.6	634	362	225	1668
f328(d42-44)	7069	26.9	13.2	614	330	204	1616
f335(d42-126)	7002	24.8	14.1	587	359	161	1618
U&I #8	6763	23.2	14.6	461	320	196	1133
f348(d43-119)	6606	23.8	13.9	599	385	235	1456
f330(d42-57)	6565	23.5	14.2	548	310	146	1656
f347(d43-118)	6354	22.2	14.3	513	282	206	1504
US22/3	5866	21.1	13.9	487	303	185	1231
f321(d41-199)	5721	21.2	13.6	565	401	170	1193
f323(d41-278)	5643	21.5	13.2	683	352	245	1831

Table C-1(continued). Yield and impurity data for 2n selections and four hybrid check varieties.

Description	Acre Yield Gross Sugar (bs.)	Acre Yield Tons Beets	Percent Sugar	Index	PPM N	PPM Na	PPM K
f319(d41-153)	5620	20.6	13.7	540	285	170	1533
f353(d43-228)	5229	20.0	13.1	723	434	226	1697
f352(d43-182)	3925	14.3	13.7	690	402	223	1850
T = 1.96							
Mean	7220	25.9	13.9	577	334	183	1600
LSD	880	3.0	0.7	109	84	46	212
C.V. Percent	10.7	10.1	4.4	16.7	22.1	22.2	11.7
Calculated F	11.6**	11.6**	2.2**	2.0**	2.1**	4.5**	5.4**

** - Significant at p = 0.01

Table C-2. Yield and impurity data for 4n selections and 4 hybrid check varieties.

	Acre Yield			PPM			
Description	Gross Sugar (Lbs.)	Tons Beets	Percent Sugar	Index	N	Na	K
GWD2	10231	37.4	13.7	602	419	202	1335
f288(d40-104)	9466	37.6	12.6	689	322	374	1660
f307A(d40-211)	8779	36.3	12.1	763	331	432	1757
f304(d40-202)	8716	36.1	12.0	793	352	419	1777
f271(d40-4)	8699	35.3	12.3	673	267	368	1732
f315(d40-267)	8504	35.3	12.1	682	265	378	1675
f280(d40-43)	8483	34.8	12.2	751	289	471	1837
f317(d40-281)	8468	34.9	12.2	759	315	417	1775
f294(d40-135)	8451	36.6	11.6	828	305	559	1815
f278(d40-32)	8447	35.8	11.9	758	253	407	1975
f314(d40-254)	8402	36.2	11.6	816	331	450	1800
f309(d40-226)	8395	35.0	12.0	785	286	472	1947
f283(d40-69)	8391	33.5	12.5	664	237	392	1805
f279(d40-39)	8382	34.5	12.2	791	286	503	1940
f251)d38-51)	8364	35.7	11.7	835	305	575	1885
f286(d40-92)	8230	32.6	12.6	642	262	369	1682
f287(d40-93)	8202	33.7	12.2	756	267	416	1972
f275(d40-22)	8186	33.0	12.4	764	296	474	1860
f284(d40-83)	8164	33.8	12.1	687	240	435	1725
f295(d40-155)	8157	33.9	12.1	740	263	386	1960
f289(d40-111)	8131	32.6	12.5	714	284	438	1805
f285(d40-88)	8124	35.0	11.6	849	329	542	1855
f305(d40-203)	8121	33.4	12.2	640	213	392	1710
f306(d40-204)	8097	35.6	11.4	845	309	488	1917
f310(d40-234)	8060	33.4	12.2	737	310	351	1775
f293(d40-133)	8058	34.1	11.8	816	302	512	1877
f302(d40-196)	7986	32.8	12.2	595	223	405	1410
f300(d40-192)	7910	34.7	11.4	869	302	512	2027
f263(d39-285)	7886	33.7	11.7	687	224	518	1520
f267(d39-336)	7862	33.2	11.8	732	321	379	1625
f318(d40-283)	7801	33.2	11.8	743	278	402	1775
f303(d40-200)	7734	33.7	11.5	821	309	533	1737
f281(d40-44)	7716	33.2	11.6	914	398	505	1942

Table C-2 (continued). Yield and impurity data for 4n selections and 4 hybrid check varieties.

	Acre Yield			PPM			
Description	Gross Sugar (Lbs.)	Tons Beets	Percent Sugar	Index	N	Na	K
f274(d40-16)	7660	33.2	11.5	808	292	525	1815
f277(d40-31)	7649	32.3	11.9	717	236	359	1960
U&I #8	7646	29.6	13.0	547	275	336	1252
f270(d39-346)	7641	32.9	11.6	766	302	513	1565
f255(d39-42)	7569	31.5	12.1	651	293	272	1565
f313(d40-251)	7564	31.8	11.8	667	256	423	1485
f292(d40-123)	7499	30.7	12.3	701	273	387	1782
f290(d40-113)	7466	33.4	11.2	788	286	469	1697
f312(d40-246)	7432	32.5	11.5	855	365	474	1770
f311(d40-241)	7355	30.8	12.1	716	279	335	1805
f291(d40-122)	7327	32.2	11.4	944	384	527	2025
f296(d40-161)	7312	31.2	11.7	825	321	541	1805
f248(d38-7)	7282	32.1	11.4	769	257	627	1672
f250(d38-31)	7222	31.2	11.6	794	278	670	1577
AH #10	7209	27.1	13.3	505	294	176	1260
f316(d40-268)	7133	29.3	12.2	795	340	471	1800
f257(d39-58)	7106	32.1	11.1	759	266	411	1700
US22/3	6583	25.4	13.0	543	278	305	1275
f261(d39-268)	6421	27.9	11.5	748	307	438	1560
f269(d39-343)	6414	30.0	10.7	881	385	499	1505
f258(d39-62)	6386	29.7	10.8	880	335	487	1752
f264(d39-315)	6322	26.7	11.9	613	216	330	1560
f254(d39-2)	6222	27.1	11.5	724	223	429	1770
f268(d39-340)	6154	26.3	11.7	684	247	353	1682
f299A(d40-174)	3291	13.1	12.5	665	264	315	1825
Mean	7732	32.4	12.0	744	293	434	1730
LSD	978	4.4	1.0	196	122	153	191
C.V. Percent	10.2	10.8	7.1	21.3	33.5	28.5	8.9
Calculated F	7.7**	5.9**	2.1**	1.7**	1.0	2.8**	7.3**

** - Significant at p = 0.01

Table C-3. Comparison between 2n selections vs check varieties and 4n selections vs check varieties for percent sugar and root yield.

Description	Test 13 (2n) Percent Sugar	Root Yield Tons/Acre	Test 14 (4n) Percent Sugar	Root Yield Tons/Acre
Check Varieties	14.3	25.0	13.2	29.9
Selections	13.8	26.0	12.0	32.6
t .05	0.3	1.0	0.4	1.5

Table D-1. Root yield, sugar percentage, and quality factors for commercial and experimental hybrids at Logan, Utah, 1976

		Acre Yield			PPM			
Code	Description	Gross Sugar (Lbs.)	Tons Beets	Percent Sugar	N	K	Na	Index
220	HH22	6755	22.6	14.9	268	1381	123	440
209	Marimono	6686	21.6	15.5	229	1277	168	392
208	Monova	6299	20.9	15.1	291	1341	191	462
211	GWD2	6171	20.5	15.0	330	1081	67	419
204	(L29XL21)XL19	6161	18.7	16.5	295	972	74	343
210	Ultramono	6103	18.9	16.1	246	1095	146	356
203	(L33XL5) X L19	6100	18.2	16.7	250	977	98	317
202	(L12XC1) X L37	6001	20.1	14.9	498	1133	82	543
212	AH10	5990	20.0	15.0	332	1077	80	422
214	USH10B	5888	19.9	14.8	296	1204	82	424
207	L-D19R1	5856	19.3	15.2	293	1168	53	399
215	USH20	5839	19.9	14.7	263	1010	158	389
221	L-H19R1	5828	18.6	15.7	258	1252	108	389
201	A7113 X L39	5817	18.0	16.2	396	1004	90	423
213	AH4	5806	19.4	14.9	252	931	93	346
218	UI 7	5766	19.1	15.1	267	887	86	346
206	{(L33XL29)XL5}XL37	5648	19.0	14.8	492	968	85	516
205	(CLXL53)X(E1X629R_f)	5574	18.4	15.2	329	989	120	410
216	US22/3	5294	17.9	14.8	292	1110	101	410
219	UI X 4	5124	17.4	14.7	322	902	111	402
217	UI 8	4856	16.3	14.9	390	1004	116	459
Mean of all entries		5884	19.3	15.3	314	1084	107	410
LSD (5% point)		618	2.0	0.6	107	109	38	84
C.V. Percent		9.2	3.2	3.2	29.9	8.8	31.4	17.9
Calculated F		4.1**	3.9**	9.4**	3.8**	13.2**	6.5**	3.4**

** - Significant at p = 0.01

Table D-2. Root yield, sugar percentage, and quality factors for commercial and experimental hybrids at Farmington, Utah, 1976.

Code	Description	Acre Yield: Gross Sugar (Lbs.)	Acre Yield: Tons Beets	Percent Sugar	PPM: N	PPM: K	PPM: Na	Index
302	(L12XC1)XL37	9119	31.0	14.7	371	1329	152	516
306	{(L33XL29)XL5}XL37	9118	32.1	14.2	390	1306	211	556
305	(C1XL53)XE1X629Rf	8956	31.0	14.4	252	1095	228	423
311	GWD2	8915	29.9	14.9	305	1341	135	462
315	USH20	8519	30.8	13.9	309	1070	315	497
303	(L33XL5)XL19	8413	25.8	16.3	280	1220	159	393
301	A7113XL39	8171	27.1	15.1	384	1158	221	500
319	UI X 4	8163	29.6	13.8	299	1064	260	479
320	HH22	7914	29.2	13.6	242	1352	178	473
313	AH4	7748	27.8	13.9	213	1227	246	436
314	USH10B	7733	27.9	13.8	243	1337	165	460
318	UI7	7711	28.0	13.7	269	985	261	444
312	AH10	7682	27.9	13.8	216	1268	183	436
321	L-H19%1	7480	24.7	15.0	207	1397	146	404
304	(L29XL21)XL19	7164	22.7	15.8	253	1112	132	365
316	US22/3	7122	25.7	13.9	336	1220	300	540
307	L-D19R1	7092	24.6	14.4	246	1289	130	428
317	UI8	6965	25.9	13.4	277	1072	262	476
310	Ultramono	6943	24.3	14.3	262	1360	343	506
309	Marimono	6563	23.1	14.1	279	1083	231	448
308	Monova	6298	22.5	14.0	199	1266	275	438
Mean of all entries		7799	27.2	14.3	278	1217	216	461
LSD (5% point)		1077	3.4	0.8	179	143	65	84
C.V. Percent		12.1	10.8	4.7	28.4	10.3	26.3	15.9
Calculated F		4.7**	5.9**	7.3**	3.0**	5.7**	7.6**	2.5**

** - Significant at p = 0.01

Table E-1. Acre yield, sugar percent, and impurity factors for Russian variety top crosses.

Description	Acre Yield: Gross Sugar (Lbs.)	Acre Yield: Tons Beets	Percent Sugar	PPM: N	PPM: K	PPM: Na	Index
GWD2	7578	26.3	14.4	434	1487	151	598
L9X645	7570	27.5	13.8	413	1768	240	685
C3X645	7247	24.8	14.6	391	1383	211	556
G1x645	7184	24.5	14.7	408	1725	193	625
L28x644	7136	25.0	14.3	443	1393	235	612
A2X651	7134	23.2	15.4	297	1368	169	455
L9X653	7132	24.7	14.4	393	1785	263	650
A2X644	7103	23.9	14.9	323	1462	213	517
L9X651	7075	24.8	14.2	365	1545	252	593
L28X651	7063	23.6	14.9	444	1300	210	564
G1X651	7022	24.1	14.6	405	1768	220	635
L9X644	6918	26.7	13.0	398	1927	312	766
L9X638	6918	24.2	14.3	361	1629	213	597
A2X645	6867	23.1	14.9	400	1508	157	561
G1X650	6856	23.6	14.5	443	1606	235	644
C3X642	6829	23.3	14.7	439	1514	185	603
A2X650	6824	22.5	15.2	334	1408	165	495
G1X638	6788	22.6	15.0	409	1629	180	589
P2X645	6786	23.1	14.8	404	1364	152	544
L28X650	6785	23.3	14.5	406	1295	211	559
C3X651	6785	23.4	14.5	440	1687	260	668
G1X644	6758	22.7	14.9	409	1612	203	593
C3X644	6722	23.8	14.1	420	1604	218	637
P2X644	6706	22.3	15.1	370	1281	123	488
G1X653	6698	24.8	13.5	463	2016	287	795
C3X638	6691	23.1	14.5	358	1500	200	555
L28X653	6640	23.7	14.0	505	1333	253	665
UI #7	6634	23.0	14.4	391	1237	158	527
G1X642	6629	22.3	14.8	425	1706	213	630
A2X638	6598	21.3	15.5	331	1350	152	467

Table E-1 (continued). Acre yield, sugar percent, and impurity factors for Russian variety top crosses.

	Acre Yield			PPM			
Description	Gross Sugar (Lbs.)	Tons Beets	Percent Sugar	N	K	Na	Index
A2X642	6498	21.8	14.9	481	1564	163	625
G1X649	6491	22.8	14.3	411	1843	245	674
L9X650	6481	22.3	14.5	376	1595	188	584
P2X651	6451	21.5	15.0	418	1204	138	512
HH22	6443	23.8	13.5	365	1518	151	594
L28X638	6440	21.8	14.8	387	1364	171	536
P2X642	6438	21.2	14.9	421	1470	139	566
A2X649	6330	21.8	14.5	350	1475	148	531
F2X653	6243	21.8	14.3	342	2052	314	681
P2X650	6221	20.7	15.0	442	1279	141	540
L9X642	6212	21.4	14.5	386	1775	260	633
F3X645	6159	20.3	15.3	439	1739	148	610
F2X649	6099	21.3	14.4	282	1904	300	600
F3X651	5847	20.0	14.6	446	1812	138	650
UI #8	5825	20.2	14.4	457	1347	203	602
P2X653	5813	20.0	14.6	505	1510	161	653
P2X638	5722	19.0	15.1	376	1179	131	475
F3X644	5491	19.2	14.2	567	1795	161	754
F3X650	5469	18.7	14.6	511	1858	191	715
US22/3	5420	19.3	14.1	466	1522	196	652
F3X638	5064	16.5	15.3	409	1547	119	549
F3X642	5013	17.5	14.4	450	2014	176	711
Mean of all entries	6536	22.5	14.6	410	1569	197	603
LSD (5% Point)	847	2.6	0.7	85	200	51	191
C.V. Percent	11.5	10.4	4.2	18.3	11.3	23.0	14.3
Calculated F	3.6**	5.4**	3.8**	3.1**	9.6**	7.2**	4.5**

** Significant difference at the .01 level.

Table E-2. Means of males and females and the A.N.O.V. for combining ability for gross sugar (lbs./acre) Russian variety top crosses. Logan, Utah, 1976.

	Females						Total	A.N.O.V.		
Males	A2	C3	F3	G1	P2	L9	Mean	Source	df	F
638	6598	6691	5064	6788	5722	6918	6297	Treat	35	3.42**
642	6498	6829	5013	6629	6300	6212	6247	Males	5	4.42**
644	7103	6722	5491	6758	6706	6918	6616	Females	5	12.60**
645	6867	7247	6159	7184	6786	7570	6969	mxf	25	1.39NS
650	6824	(6613)†	5469	6856	6221	6481	6411			
651	7134	6785	5847	7022	6451	7075	6719	LSD 0.05 = 365		
Total	6837	6815	5507	6873	6364	6862				

Table E-3. Means of males and females and the A.N.O.V. for combining ability for beet weight (T/A) for Russian variety top crosses. Logan, Utah, 1976.

	Females						Total	A.N.O.V.		
Males	A2	C3	F3	G1	P2	L9	Mean	Source	df	F
638	21.3	23.1	16.5	22.6	19.0	24.2	21.1	Treat	35	5.13**
642	21.8	23.3	17.5	22.3	21.2	21.4	21.3	Males	5	7.17**
644	23.9	23.8	19.2	22.7	22.3	26.7	23.1	Females	5	24.40**
645	23.9	24.8	20.3	24.5	23.1	27.5	23.9	mxf	25	0.88NS
650	22.5	(22.6)†	18.7	23.6	20.7	22.3	21.7	LSD 0.05 = 1.2		
651	23.2	23.4	20.0	24.1	21.5	24.8	22.8			
Total	22.6	23.5	18.7	23.3	21.3	24.5				

Table E-4. Means of males and females and the A.N.O.V. for combining ability for sugar percent for Russian variety top crosses, Logan, Utah, 1976.

	Females						Total	A.N.O.V.		
Males	A2	C3	F3	G1	P2	L9	Mean	Source	df	F
638	15.5	14.5	15.3	15.0	15.1	14.3	14.95	Treat	35	3.18**
642	14.9	14.7	14.4	14.8	14.9	14.5	14.7	Males	5	5.16**
644	14.9	14.1	14.2	14.9	15.1	13.0	14.4	Females	5	13.05**
645	14.9	14.6	15.3	14.7	14.8	13.8	14.7	mxf	25	1.7 *
650	15.2	(14.6)†	14.6	14.5	15.0	14.5	14.7			
651	15.4	14.5	14.6	14.6	15.0	14.2	14.7	LSD 0.05 = 0.03		
Total	15.1	14.5	14.7	14.75	15.0	14.05				

† Numbers in ( ) = calculation by averaging both ways.

* Significant difference at the .05 level.

** Significant difference at the .01 level

Table F-1. Root yield, sugar percent, and impurity factors for Polish varieties.

Description	Gross Sugar Lbs./Acre	Root Yield Tons/Acre	Percent Sugar	N	K	Na	Index
D2	7169	25.0	14.4	354	1554	126	550
Tetr. Tri. Poly.	6215	19.9	15.6	322	1525	162	490
Poli. 2	5747	18.3	15.7	293	1391	175	447
P. Poly	5621	17.6	16.0	321	1312	131	436
P. Poly	5524	17.7	15.6	279	1462	210	461
Aj Poly. 2	5333	17.3	15.8	378	1458	158	519
P. Poly	5149	16.7	15.3	358	1229	160	471
Poly. Mono.	4756	16.0	14.7	407	1845	222	649
C17	4670	16.2	14.4	376	1654	117	579
Poly 2	4615	15.6	14.9	234	1316	151	414
P. Poly	4543	15.0	15.3	355	1191	113	458
L19	3565	10.1	17.6	313	1095	98	353
Tetr-Tri Poly Mono	3447	11.9	14.8	473	1591	171	639
L8	2834	10.4	13.8	452	1195	197	596
LSD	834	3.0	1.4	139	325	72	170
F	4.0**	3.5**	3.8**	1.8	3.5**	2.3*	2.2*
C.V.	20.1	21.7	5.3	23.6	13.7	27.2	5.3
Mean	1235	4.1	15.3	351	1416	156	505

Table G-1. Comparison of individual beet selection methods for sugar percentage.

	Sugar Percentage of Selection	Sugar Percentage of Parent
Sp. gr. #1	17.5*	15.2
Sp. gr. #3	17.0	14.6
H S. Plug	17.7*	17.0
L S. Plug	17.2	12.5
H S. Shred	17.6*	16.8
L S. Shred	17.2	13.0

* Significant difference at the .05 level.

II. GROWTH ANALYSIS

EFFECT OF PLANTING DATE ON SUGAR ACCUMULATION

Devon L. Doney and J. Clair Theurer

An earlier observation indicated that the same aged and/or sized plants accumulate sugar more rapidly in the later part of the summer than at earlier periods.

In order to investigate this observation more thoroughly, a multiple-planting and harvesting date experiment was conducted. Four inbreds and four hybrids, differing in yield and sugar accumulation potential, were planted in a split-split plot design. Planting dates were at three-week intervals (June 3, June 24, and July 14). Harvest dates began when the plants were six weeks old and every three weeks thereafter (Table 1). At each harvest date, data were taken on top weight, root, weight, and percent sugar.

The roots grew more rapidly for the June 24 planting date than the other planting dates (Table 2). The later in the season the planting the more rapidly the same aged plants accumulated sugar (Table 2). This reaction was similar for all hybrids and inbreds even though there was a great difference in yield and sugar percent among the entries.

This reaction summed over all entries is plotted in Figure 1. At six weeks of age, the June 3 planted plants had 6.1 percent sugar, whereas the June 24 planted plants had 9.1 percent sugar, and the July 14 planted plants had 11.1 percent sugar.

There appears to be some relationship between root size and percent sugar. However, when the root size was plotted against percent sugar (Figure 2), the later the planting date the more rapidly the same sized roots accumulated sugar. This difference appeared to be consistent until the beets reached close to their maximum sugar potential and then converged with increasing root size (Figure 2).

There are two climatic factors that could be responsible for triggering the plants to accumulate sugar more rapidly. These are cooler night temperatures and decreasing day length. At present, climatic factors x sugar accumulation data are not analyzed and cannot be included with this report. This data will be evaluated for its relative importance in the near future.

Table 1. Planting and harvest dates.

	Planting Dates		
Harvesting Dates	June 3	June 24	July 14
July 19	X		
August 9	X	X	
August 30	X	X	X
September 20	X	X	X

X = harvest dates for each planting.

Table 2. Root weight and percent sugar for each harvest, planting date, and variety.

Line	Harvest Date	Root Wt. Tons/Acre Planting Date June 3	June 24	July 14	Percent Sugar Planting Date June 3	June 24	July 14
L37	7/19	0.3			4.7		
	8/9	2.7	0.7		13.0	8.3	
	8/30	4.7	3.3	0.7	17.4	16.5	10.2
	9/20	6.3	7.1	3.0	17.6	17.2	14.2
L19	7/19	0.4			6.4		
	8/9	2.8	0.7		15.2	8.2	
	8/30	4.9	3.8	0.4	21.3	18.4	12.0
	9/20	8.0	5.8	3.3	20.3	19.5	17.4
L8	7/19	0.2			6.6		
	8/9	1.8	0.4		14.7	9.2	
	8/30	2.7	1.7	0.6	17.5	16.4	11.5
	9/20	7.9	4.4	2.2	17.6	17.7	15.6
C13	7/19	0.4			5.4		
	8/9	3.8	1.0		12.9	9.1	
	8/30	8.9	4.9	0.9	15.0	13.9	10.3
	9/20	14.7	11.8	4.4	15.8	15.9	13.4
L53x37	7/19	0.7			6.2		
	8/9	5.6	1.4		13.6	10.2	
	8/30	11.0	5.5	1.1	16.6	15.4	11.5
	9/20	16.3	13.8	5.6	17.1	17.2	15.2
L53xL19	7/19	0.9			6.4		
	8/9	6.1	1.3		14.6	9.1	
	8/30	12.3	6.7	1.3	16.8	16.6	11.9
	9/20	17.4	12.6	6.1	18.2	18.1	16.9
L53x28	7/19	0.6			7.0		
	8/9	4.1	1.2		14.6	9.5	
	8/30	8.2	5.3	1.0	16.9	15.0	11.3
	9/20	12.6	8.5	4.4	17.8	17.2	14.7
L53xC13	7/19	0.8			6.0		
	8/9	5.8	1.2		13.4	8.9	
	8/30	12.1	7.1	1.1	15.2	14.4	10.2
	9/20	20.9	15.5	5.0	15.7	16.1	14.7
Totals	7/19	0.6			6.1		
	8/9	4.1	1.0		14.0	9.1	
	8/30	8.1	4.8	0.9	17.1	15.8	11.1
	9.20	13.0	9.9	4.3	17.5	17.4	15.3

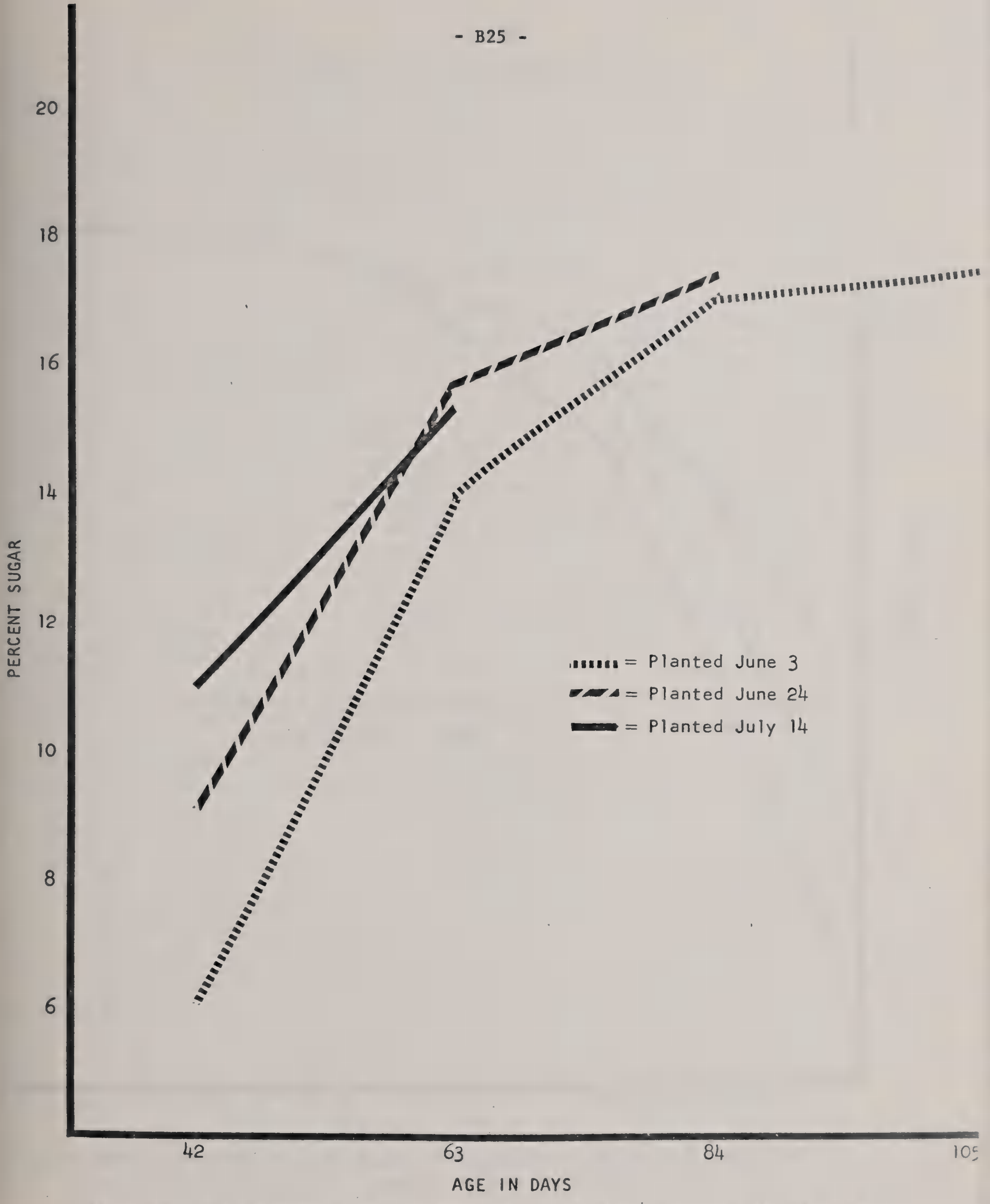

Figure 1. The percent sugar vs. age of plants for the three planting dates. Data are means of all varieties.

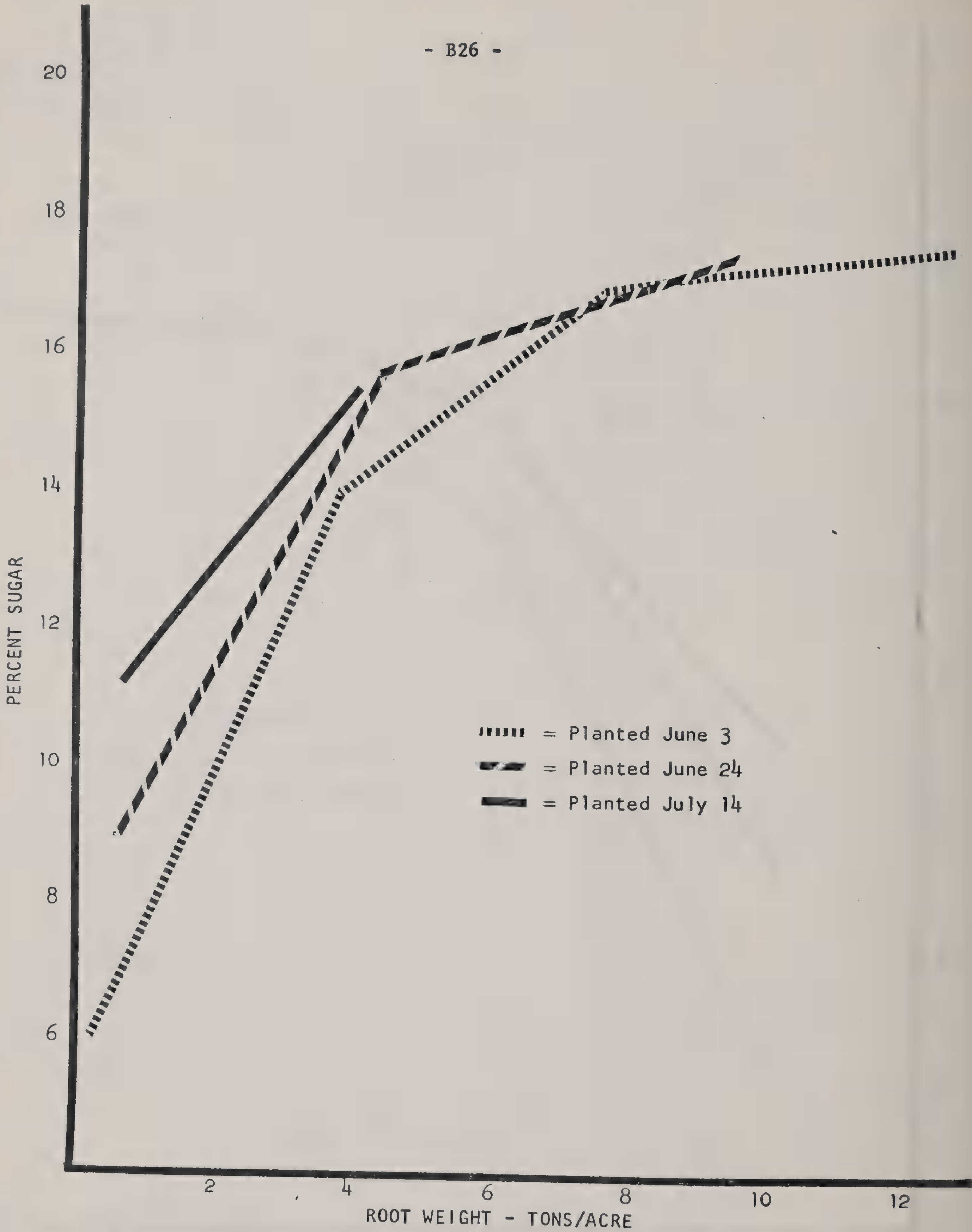

Figure 2: The percent sugar vs. root weight for the three planting dates. Data are mean of all varieties.

GROWTH ANALYSIS OF INBREDS AND HYBRIDS

J. Clair Theurer and Devon L. Doney

In 1975, an experiment was established at Logan, Utah, to compare some of the morphological growth factors of inbreds of diverse genotype and to note the relationship of morphological characteristics and their hybrids. This experiment was continued in 1976.

MATERIALS AND METHODS

Seed of nine inbreds and sixteen hybrids was planted in single rows 20 feet long and 22 feet wide. There were six replicates in the test. They were carefully thinned, using a measuring stick to establish a complete stand with beets 15 inches apart in the row.

Five plants were selected in each row for morphological characterization and were tagged with 1 to 5 numbered stakes. When the plants were approximately six weeks old, each individual leaf blade was measured on each plant for width and length using a 1 cm square grid chart. Measurements were made at weekly intervals on each plant during the growing season and data were recorded on a tape recorder. One student made all measurements from July 14 to August 25 reading. Measurements were also taken September 1 and September 15; however, these data are not given in this report. Due to misunderstanding as to how the plants were to be read, there was too much variation and discrepancy in the data taken September 1 and September 17 for it to be meaningful.

The total number of leaves on each plant and an estimate of leaf area (leaf width x leaf length) were generated from the measurement data.

On September 16, all plots were harvested. The tops were removed by hand, and both root weight and top weight were obtained for each entry.

RESULTS

The gross sugar, root weight, and sugar percent for the inbreds and hybrids are given in Table 1. Hybrids with L53 parentage were highest in yield, and those with L19 parentage had the greatest sugar percentage. The relative performance of inbreds and hybrids was similar to data collected in 1975 for sugar percentage but not for root yield. The seasonal interaction may have been influenced by the short growing season and also by a lack of optimum nitrogen fertilizer.

In general, inbreds having the greatest green top weight were also those having the greatest root weight. There was no consistent relationship, however, of top size with root yield in the hybrids.

Most inbreds showed a rapid increase in leaf width and leaf length until the first part of August. Thereafter, there was a gradual

decrease in leaf size for the balance of the season. This, no doubt, was due to the change from top-sink strength dominance to root-sink strength dominance. L53 and L19 had the smallest leaves of the inbreds at all readings after July 28. R2 and L37 were the lines exhibiting the greatest leaf size. L19 and A5 inbreds did not reach their maximum leaf width until the middle of August, one week later than the other inbreds. However, L53, L19, and A5 inbreds reached their maximum leaf length one week earlier than the other inbreds. This shows a compensating effect for leaf width and leaf length

Hybrids showed similar leaf width and length to their inbred parents, and in all cases except for hybrids L29xL38, L29xC12, L29xL8, and L29xR2 there was heterosis for these characteristics.

The leaf area for the inbreds is shown in Figure 1. R2, L37, and L38 have the largest leaf area and L53 the smallest. A5 and L19 reached their greatest leaf area by the July 28 reading. All other inbreds reached maximum leaf area a week later, August 4. The pattern of leaf development was quite similar for the inbreds. However, there was a significant difference in growth rate. At the first measurement, there was 26.2 sq. cm. difference between the average size of leaf of R2 (largest) and L53 (smallest). At maximum leaf area development (August 14), the difference was 112 sq. cm. and at the last reading (August 25) 86 sq. cm. between these two lines.

Mean leaf area of hybrids grouped by male parent showed similar growth patterns to that of the inbreds (Figure 2). The maximum leaf area was observed on August 4, the same date as most of the inbreds showed their maximum leaf area. This observation conflicts with data gathered in 1975. Last year, the hybrids reached their maximum leaf size one to two weeks prior to when the inbreds had their maximum leaf area. Only three hybrids, L29xC13, A5xL19, and L53xL38, reached a maximum leaf area ahead of inbreds.

There was a steady increase in leaf number of both inbreds and hybrids (Figures 3 and 4). L19 and L53 inbreds hybrids had the greatest number of leaves. This was a compensation for these lines having the smallest average leaf area. L19 and L38 hybrids had the largest number of leaves on the average.

Correlation coefficients of mean leaf area and total leaf area (mean leaf area x number of leaves) for the four periods when leaf area was increasing during the growing season are given in Table 2. The correlation values were higher for inbreds after approximately 48 days growth (July 21 reading) than for other growth periods. There was little difference between the correlation values for hybrids at the different growth periods. Correlations with sugar percent were all non-significant. Correlation values for mean leaf area and total leaf area were very similar.

One must conclude that the yield of beets and sugar content cannot be predicted for hybrids on the basis of critical measurements on the leaf area of the tops.

Table 1. Gross sugar, beet weight, sugar percent, and top weight for inbreds and hybrids in growth analysis experiment. Evans Farm, Logan, Utah 1976.

Code	Description	Acre Yield: Gross Sugar (lbs.)	Acre Yield: Tons Beets	Percent Sugar	Top Weight
1011	L53xL19	5827	16.2	17.9	12.0
1013	L53xL38	5618	16.6	17.0	11.7
1012	L53xL37	5493	16.3	16.8	9.0
1003	A5xL38	5403	16.1	16.8	13.2
1001	A5xL19	5331	14.8	17.9	12.7
1006	L29xL37	5311	16.0	16.7	9.2
1014	L53xC13	5232	17.3	15.2	14.0
1002	A5xL37	5139	15.0	17.2	8.7
1007	L29xL38	5012	15.0	16.8	10.3
1016	L53xR2	4853	14.7	16.5	10.7
1005	L29xL19	4739	13.5	17.7	11.0
1010	L29xR2	4556	14.0	16.3	10.5
1004	A5xC13	4547	15.2	15.0	12.8
1015	L53xL8	4547	13.2	17.1	10.0
1008	L29xC13	4338	13.3	16.3	8.7
1009	L29xL8	3983	11.6	17.2	10.3
1023	C13	3883	12.7	15.2	8.8
1022	L38	3430	10.5	16.3	9.5
1020	L19	3408	9.6	18.4	8.5
1025	R2	2938	8.8	16.6	6.0
1021	L37	2617	7.6	17.1	4.8
1018	L29	2593	7.6	17.1	6.0
1017	A5	2442	7.0	17.4	5.2
1024	L8	2337	6.6	17.7	5.2
1019	L53	1703	4.7	18.0	3.0
Mean of all varieties		4212	12.6	16.9	9.3
LSD (5% point)		680	2.0	1.2	2.1
C. V. Percent		14.1	14.2	6.4	20.4
Calculated F		24.6**	25.7**	3.9**	14.0**

** Significant difference at the .01 level.

Table 2. Correlation coefficients of mean leaf area and total leaf area with root weight and sugar percent by growth period.

	Growth Period (Days)			
	41	48	55	62
Inbreds	7/14	7/21	7/28	8/4
Mean leaf area x root weight	0.69	0.83	0.49	0.50
Total leaf area x root weight	0.66	0.85	0.62	0.71
Mean leaf area x sugar %	-0.47	-0.67	-0.50	-0.38
Total leaf area x sugar %	-0.41	-0.57	-0.36	-0.52
Hybrids				
Mean leaf area x root weight	0.61	0.52	0.63	0.66
Total leaf area x root weight	0.64	0.60	0.66	0.60
Mean leaf area x sugar %	-0.47	-0.24	-0.17	-0.39
Total leaf area x sugar %	-0.22	-0.22	-0.14	-0.009

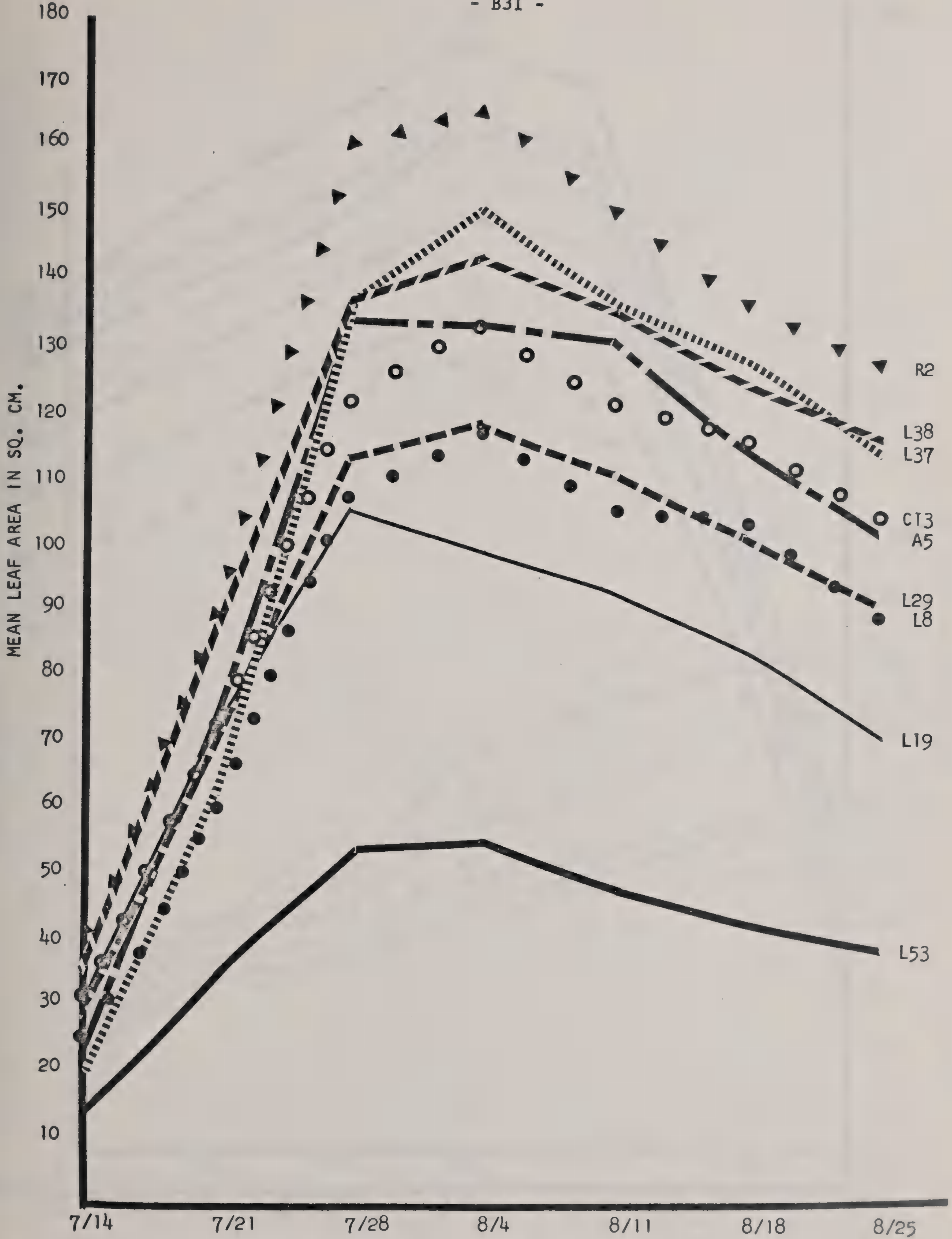

Fig. 1 LEAF AREA OF INBRED VARIETIES - 1976

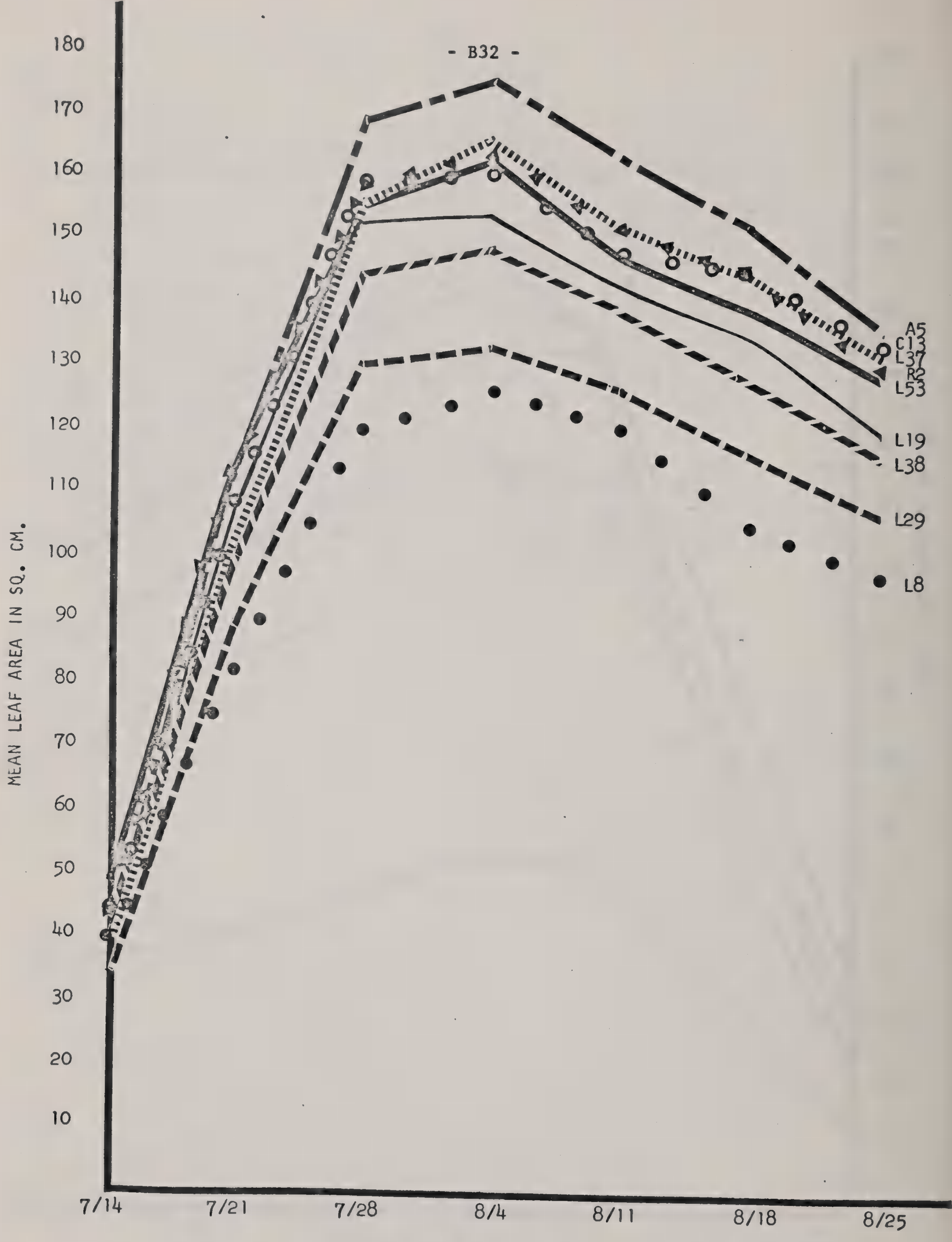

Fig. 2 MEAN LEAF AREA OF HYBRIDS HAVING INDICATED INBRED AS A PARENT - 1976.

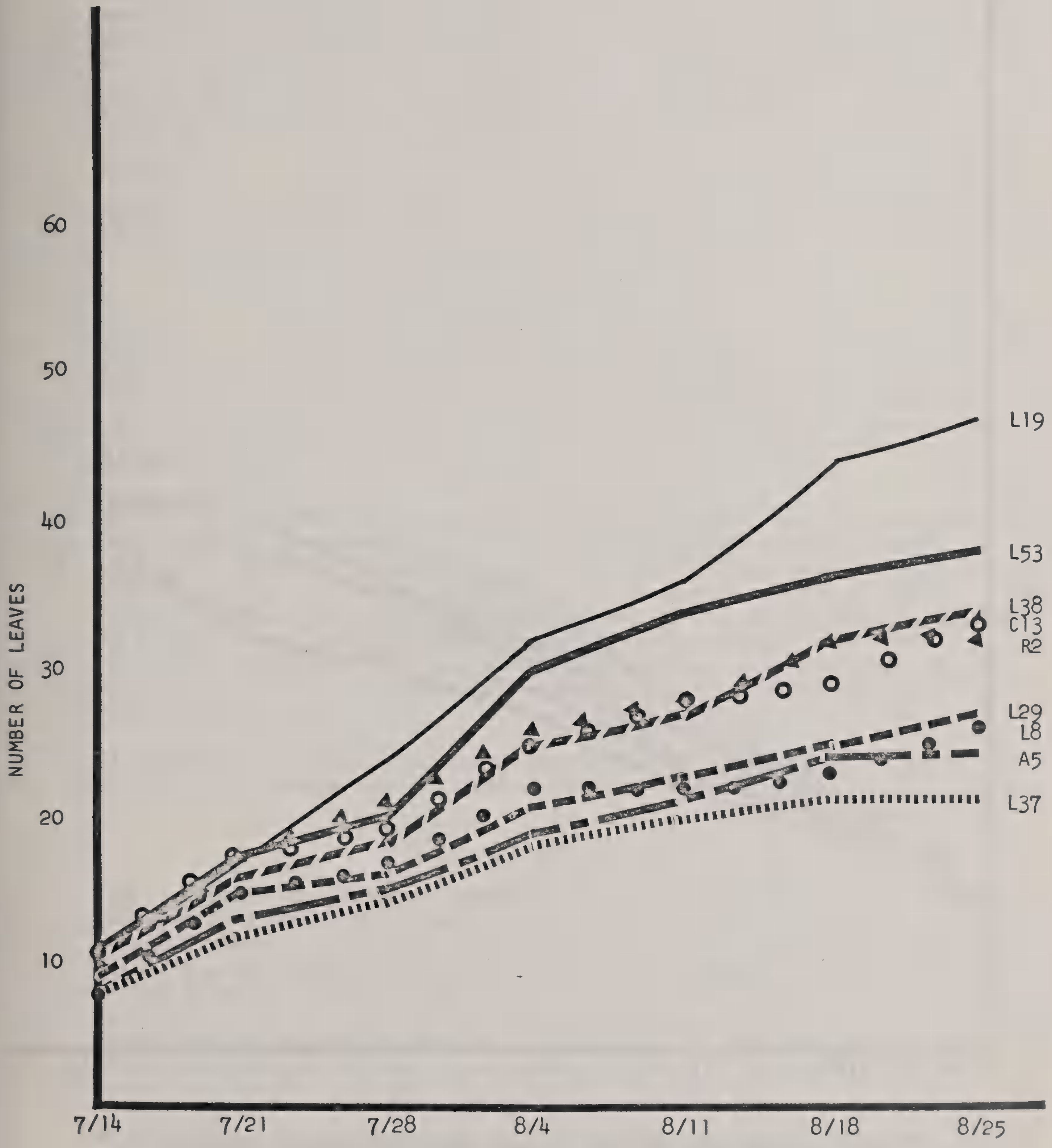

Fig. 3 NUMBER OF LEAVES VS. DATES - INBRED VARIETIES - 1976

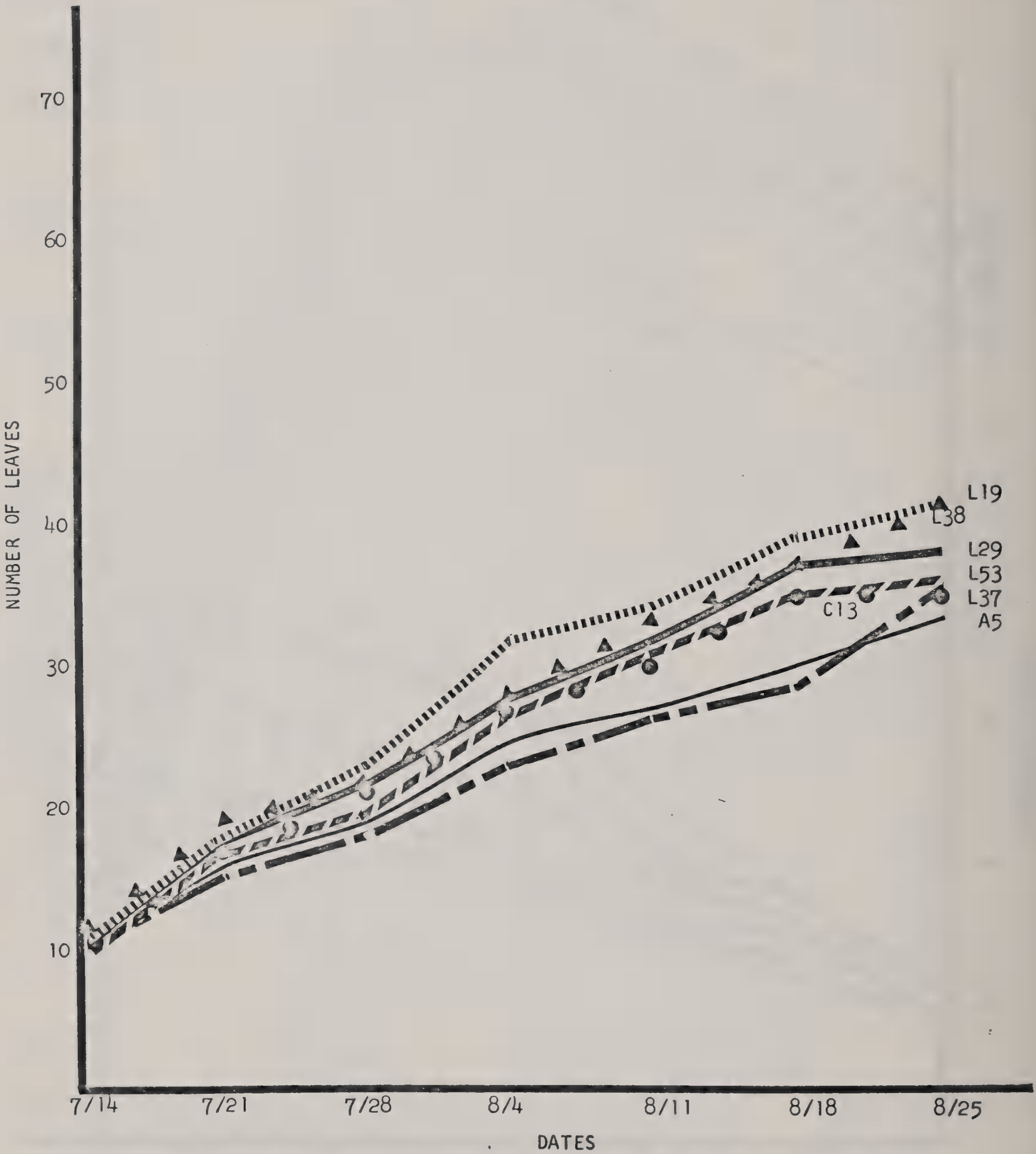

FIGURE 4 MEAN LEAF AREA OF HYBRIDS HAVING INDICATED INBRED AS A PARENT - 1976

EFFECT OF LEAF CANOPY AND PLANT DENSITY ON YIELD

J. Clair Theurer

In the early development of the sugar beet plant, the available photosynthate is partitioned mainly to the top. As the root expands and develops, it gradually becomes the dominant sink for photosynthate. We lack basic knowledge as to how and when this change in sink strength occurs, what, if any, type of leaf structure enhances sink strength in the direction we want it to go, and what possibilities there are to alter the sink strength relationship by selection or by cultural practices.

A study was established this year at Logan, Utah, to evaluate the effect of planting density and different types of sugar beet canopies on yield.

MATERIALS AND METHODS

Three lines were used in the test: 1201 had a prostrate growth wherein leaves actually rested on or near the ground; 1203 had erect growth with leaves almost vertical; and 1202 was intermediate between these extremes. The lines had similar vigor but were not isogenic. Therefore, comparisons between the three lines for yield and sugar percentage are not meaningful.

Seed of each of the three selected lines was planted in soil in Japanese paper pots in the greenhouse. After approximately one month's growth, on June 4, 1976, the seedlings were transplanted to the field by hand. Each plot was a single row 22 feet long. A commercial variety, UI8, was planted in an adjacent row between each plot and at the same density as the test lines. The design was a split-plot replicated four times with plant density as whole plots. Plant densities were 6, 12, and 24-inch spacings within the row. Two rows of UI8 separated the different planting densities.

All plots were harvested September 15, 1976. Top weight, root weight, and sugar percentage were determined for each line.

RESULTS

The prostrate line showed no phenotypic difference in any of the planting densities during the growing season. The erect and semi-erect lines tended to show less vertical type canopy at the 24-inch densities than at the 6-or 12-inch spacings. Root yield data is given in Table 1. Plants grown in 12-inch spacings significantly out-yielded those with more competition, 6-inch, or with less competition, 24-inch spacings. There were no significant differences among any of the densities for the three genotypes for sugar percentage (Table 2). The results for gross sugar were similar to those for root yield (Table 3).

The 6-inch spacing consistently showed the greatest fresh top weight (Table 4). There was little difference between the top weight of the

12-inch and the 24-inch spacings for the three canopy types.

It would appear that canopy type has little, if any, effect on partitioning of photosynthate but that plant density can affect this partitioning.

Table 1. Root yield tons/acre of three canopy types at three plant densities. Logan, Utah. 1976

	Canopy Type			
Density	1201 Prostrate	1202 Semi	1203 Erect	Mean
6"	6.84	6.27	5.93	6.45
12"	7.75	7.64	7.18	7.52
24"	7.07	5.93	5.47	6.16
Mean	7.22	6.61	6.19	

LSD for density and canopy type = 0.50
LSD for density x canopy interaction = 0.88

Table 2. Sugar percentage of three canopy types at three plant densities. Logan, Utah. 1976.

	Canopy Type			
Density	1201 Prostrate	1202 Semi	1203 Erect	Mean
6"	15.7	15.9	15.5	15.7
12"	15.9	15.6	15.2	15.6
24"	15.8	16.2	15.9	16.0
Mean	15.8	15.9	15.5	

LSD for density and canopy type 0.50
LSD for density x canopy interaction = 0.86

Table 3. Gross sugar yield (lbs/acre) of three canopy types at three plant densities. Logan, Utah. 1976.

	Canopy Type			
Density	1201 Prostrate	1202 Semi	1203 Erect	Mean
6"	2136	1992	1841	1990
12"	2465	2387	2189	2347
24"	2227	1922	1738	1996
Mean	2276	2100	1923	

LSD for density and canopy type = 167
LSD for density x canopy interaction = 289

Table 4. Fresh top weight (lbs./plot) of three canopy types at three plant densities. Logan, Utah. 1976.

	Canopy Type			
Density	1201 Prostrate	1202 Semi	1203 Erect	Mean
6"	10.25	16.25	16.25	14.25
12"	8.75	13.25	11.75	11.25
24"	8.75	12.75	10.75	10.75
Mean	9.25		12.92	

LSD for density and canopy type = 1.24
LSD for density x canopy interaction = 2.14

HYPOCOTYL DIAMETER FIELD TEST

Devon L. Doney

A series of closely related lines differing in sugar concentration potential were tested for hypocotyl diameter in the greenhouse. These measurements were used to obtain an estimate of root yield, using GWD2 as a standard (Table 2). These lines were also planted in the field in a replicated field trial. The test was in a variable part of the field and replicated only three times. This resulted in a large CV and large LSD (Table 2). However, the yield data fit the estimated yield data fairly well except for one line (75802-53).

We have no explanation for this exception unless there was a mixup in seed either at testing time or at planting time. There was also significant differences in percent sugar, sodium, and potassium (Table 2).

Table 2. Estimated yields, field yields, and quality factors for lines tested for hypocotyl diameter.

Description	Acre Yield Gross Sugar	 Tons Beets	Percent Sugar	PPM Index	 N	 Na	 K	Est. Yield[a] Tons/Acre
75802-53	6624	20.6	16.0	500	418	130	1341	15.5
75801-119	6105	20.3	15.1	386	267	82	1137	20.0
75801-24	6004	18.7	16.1	464	408	68	1225	17.8
GWD2	5861	19.9	14.8	460	366	67	1150	20.0
75801-110	5821	18.1	16.1	360	321	60	950	17.8
75801-117	5498	18.9	14.6	420	317	86	1054	19.2
75801-42	5468	17.9	15.2	429	306	80	1287	18.8
75802-37	5415	18.2	14.8	437	282	86	1350	18.6
75802-28	5125	18.0	14.2	424	235	121	1304	18.5
75802-20	4285	13.4	16.0	438	353	130	1208	16.7
L 19	4181	12.2	17.1	363	325	102	1004	-
Mean	5490	17.8	15.5	426	328	92	1183	
LSD	1202	3.6	.8	120	159	36	152	
C. V. Percent	12.9	12.0	3.2	16.5	28.6	22.8	7.5	
Calculated F	3.3**	4.7**	9.4**	1.1	1.1	4.3**	7.1**	

[a] = Based on hypocotyl diameter measurements.

HYPOCOTYL DIAMETER TECHNIQUE IN A RECURRENT SELECTION BREEDING PROGRAM

Devon L. Doney

The hypocotyl diameter of three-week-old seedlings has been shown to be fairly accurate in predicting root yield (1974 and 1975 Sugarbeet Research Report). This past year we initiated a recurrent selection breeding program using the hypocotyl diameter technique to gain an estimate of root yield combining ability.

It takes approximately three to four years to complete one recurrent selection cycle using the conventional techniques of testing for root-yield combining ability. By the use of the hypocotyl diameter technique, this cycle can be reduced to one year.

The procedure is illustrated in Figure 1. Seed is planted for stecklings in April. By the first of July, they are one to two inches in diameter and can be harvested and placed in the cold room for photothermal induction. After sufficient photothermal induction (October), each plant is cut in half. One half is retained in the cold room while the other half is potted in the greenhouse, allowed to bolt, and crossed to a cms tester line. This takes about three months. The seed from these crosses are tested for combining ability by the hypocotyl diameter technique in the greenhouse during January and February. At the same time (January), the second half of each root is brought out of the cold room and potted in the greenhouse for bolting. By the time the second half root is bolting, the results of the hypocotyl diameter tests for root yield combining ability are available. Based on these data the poor combining ability roots are discarded, and the better combining ones are retained for an open-pollinated polycross of the best roots. Seed from this polycross should be mature by April in order to start the next cycle (Figure 1).

In our first cycle, we started with 200 roots. One hundred seventy were tested in the hypocotyl diameter test for combining ability. Of these, 20 were selected as the best genotypes and were polycrossed. In order to test our progress, 20 of the poor genotypes were open-pollinated in a polycross. Seed from these two polycrosses, plus the parent, will be crossed to the cms tester and tested in a replicated field trial in 1977.

Some of the remnant seed of the test crosses were planted in a replicated field trial in 1976. Because of the small amount of seed available, all plants were transplanted. The results of this test are shown in Table 1. Three commercial varieties were included as checks.

The test cross of the best genotypes significantly out-yielded the test cross of the poor genotypes by 18 percent (Table 1). This compares favorably with the hypocotyl data in that the test cross of the best genotypes had a 12 percent larger hypocotyl diameter than the test cross of the poor genotypes. There was no difference in percent sugar nor the other impurity factors (Table 1).

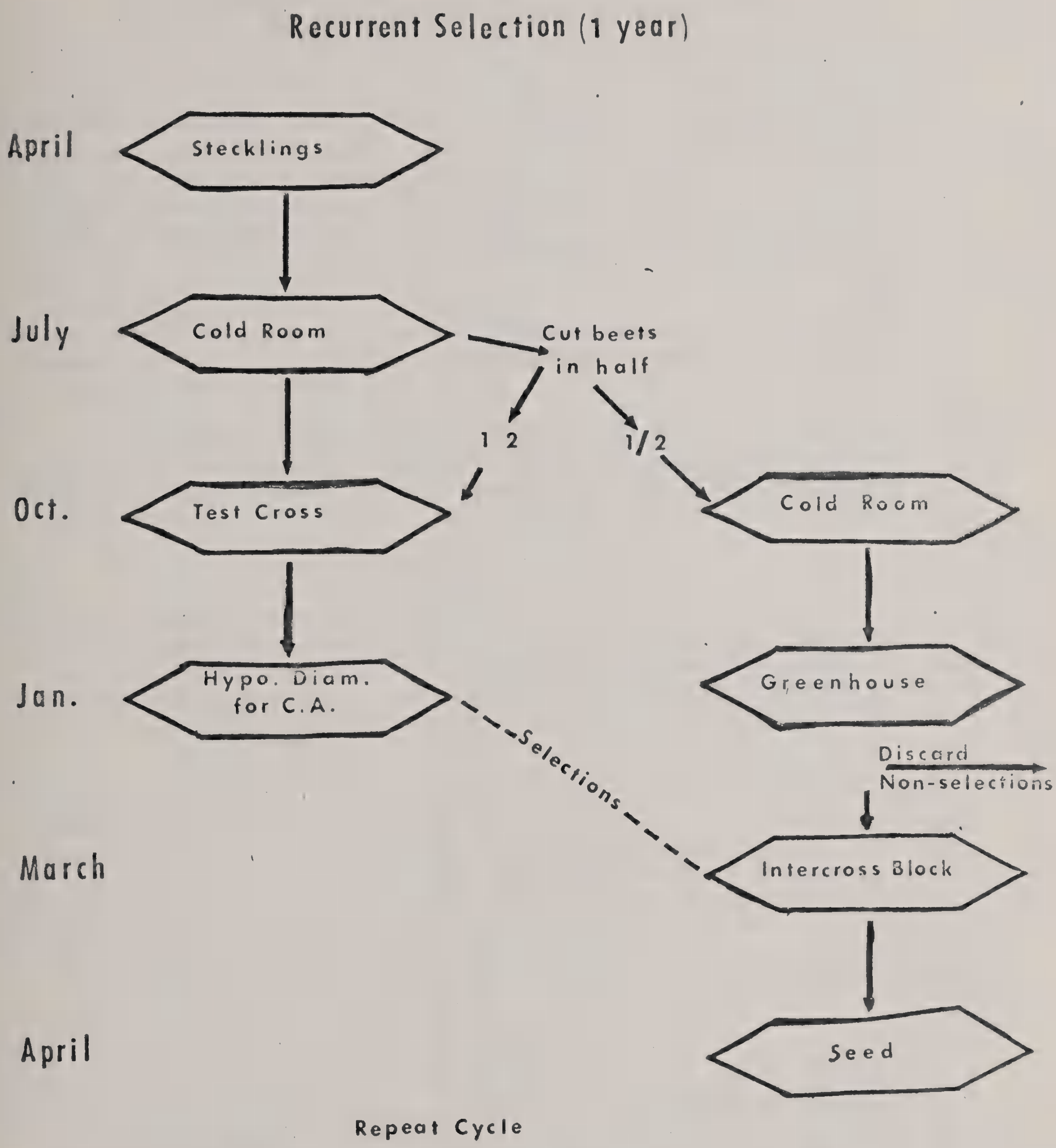

Figure 1. Flow diagram for a one year recurrent selection breeding method utilizing the Hypocotyl diameter Technique.

Table 1. Yield and quality data for the test cross of the best genotypes, test cross of the poor genotypes, and three check varieties.

	Acre Yield			PPM			
Description	Gross Sugar	Tons Beets	Percent Sugar	Index	N	Na	K
L53CMS x best F1 roots	5839	21.1	13.8	573	362	192	1452
GWD2	5782	20.9	13.9	573	398	124	1417
AH10	5451	19.8	13.8	548	377	129	1322
USH20	5405	20.2	13.4	641	421	246	1400
L53CMS x poor F1 roots	4910	17.9	13.7	666	421	239	1615
Mean	5477	20.0	13.7	601	396	186	1442
LSD	870	2.6	0.7	109	49	48	282
C. V. Percent	11.8	9.8	3.8	13.6	19.7	19.4	14.6
Calculated F	1.6	2.1*	0.6	1.9	0.6	12.8*	1.3

* Significant difference at the .05 level.

SEASONAL ACCUMULATION RATE OF SUGAR FOR YIELD AND SUGAR TYPE INBREDS AND HYBRIDS

J. Clair Theurer and Devon L. Doney

During the initial year (1975) of our studies on growth analysis of the sugarbeet, we evaluated nine inbreds and eleven hybrids selected for different sugar content, root yield, and combining ability. Growth factors for most entries were parallel. Highest yielding lines at the first harvest were highest at the last harvest, and all inbreds increased in sugar content at the same rate with one exception. Inbred L19, a high sugar line, was one of the lowest in percent sugar at the first harvest, but it increased at a much faster rate during the growing season and showed a 2.7 percent higher sugar percentage over other inbreds at the final harvest (see Figure 3, page 52, Sugar Beet Research 1975 Report).

We established a variety trial in 1976 to note if this phenomenon was unique for L19 and to determine if the rate observed for sugar and yield type inbreds was manifested in hybrids with these inbreds as parents.

MATERIAL AND METHODS

Seven inbreds of diverse origin and 12 of the possible F_1 crosses between these inbreds were planted in a split-split plot experiment at Logan. A hybrid variety and an inbred were used as a buffer between the hybrid and the inbred sections of each of the six replicates. Each single plot consisted of two rows 22 inches apart and 20 feet long.

Three harvests were made during the season. The first was made July 21, 11 weeks after planting. The second and final harvests were made September 1 and October 12, six and twelve weeks later, respectively. Ten feet of the two rows in each plot were harvested by hand, and both tops and roots were weighed. Two representative tops from each plot were weighed when green and after drying to get an estimation of the dry weight of the tops of each variety. A sample of pulp from each plot was also weighed and dried to determine differences on a dry weight basis. All harvested roots were washed and sampled by a multiple-blade Spreckels saw, and the sugar percent was determined.

RESULTS

Gross sugar and root weight by harvest dates are given in Tables 1 and 2. Both variables show a linear response for hybrids and inbreds except for L53 and A1. These two inbreds had little development in root weight between the second and third harvests. C13 showed the most rapid rate of increase in root weight for the inbreds, but L37 hybrids exhibited the greatest rate of root development.

Sugar percent by harvest dates also showed somewhat of a linear trend (Table 3 and Figures 1 and 2). The rate of sugar accumulation was greater during the six weeks between the first and second harvest than during the six weeks between second and third harvest. Of special

note is the observation that L19 had the most rapid rate of sugar accumulation of all the inbreds between harvests (Figure 1). Sugar percentage at the first harvest for L19 was less than that of L37 and L53. The same relationship can be observed for L19 hybrids (Figure 2). The rapid rate of increase in sugar was also noted last year for L19 (see 1975 Research Report, page B52). At the first harvest, L53 had a higher sugar percentage as an inbred and also in hybrid combinations. This line maintained its initial advantage during the growing season and was second to L19 in sugar percentage of inbreds and hybrids at the end of the growing season. C13, a high-yield inbred, had the lowest sugar percent at the first harvest and showed this disadvantage during the balance of the season, both as an inbred and as a hybrid.

Percent dry matter for roots and tops for the first and third harvests is shown in Table 4. L19 had the highest percent dry matter in both roots and tops of all the inbreds except for roots at the first harvest. L8 and L53 also had relatively high percent dry matter. C13, a yield type inbred, had low percent dry matter in roots and tops. Data in 1975 suggested there was a good correlation with dry matter and sugar percent. The dry matter percent of L37, a high-yield inbred, had high dry matter which counteracts the possibility of using dry matter as a relative indication of sugar content in inbreds. L8 and L53 hybrids averaged the greatest percent dry weight for roots and tops for the first harvest and for roots for the third harvest. L19 hybrids were highest in dry matter for roots for the third harvest. C13 hybrids consistently showed the lowest percent dry matter in roots and tops. Correlation between the percent dry matter of roots vs tops was 0.45* for the first harvest and 0.56* for the third harvest. Correlations between percent dry matter of the root and sugar percent were 0.77** for the first harvest and 0.89** for the third harvest. Percent dry matter of tops vs sugar percent showed non-significant correlations of 0.41 and 0.28 for the first and third harvests, respectively.

Table 1. Gross sugar yield by harvest dates. Seasonal accumulation rate study, Logan, Utah. 1976.

		Harvest		
Code	Description	#1 (Lbs./Acre)	#2 (Lbs./Acre)	#3 (Lbs./Acre)
101	L8	565	3786	5761
102	L19	499	3733	5899
103	L37	393	2562	5074
104	C13	571	4167	7503
105	L53	249	2993	3381
106	A1	159	2052	2504
107	F6	335	2874	5281
108	L53xL8	599	4154	6513
109	A1xL8	858	4363	7124
110	F6xL8	597	3687	5764
111	L53xL19	915	4842	7389
112	A1xL19	495	3989	6346
113	F6xL19	511	3487	6939
114	L53xL37	715	5240	8693
115	A1xL37	884	5276	9485
116	F6xL37	802	5096	8884
117	L53xC13	647	4649	7812
118	A1xC13	548	3933	6980
119	F6xC13	740	4047	7690
120	GWD2	725	5051	8841
LSD		203	722	1100
C. V.		30.1	15.8	14.5
Mean		590	3999	6694

Table 2. Root weight by harvest dates - Seasonal accumulation rate study, Logan, Utah. 1976.

		Harvest		
Code	Description	#1 (Tons/Acre)	#2 (Tons/Acre)	#3 (Tons/Acre)
101	L8	2.93	13.8	20.8
102	L19	2.63	11.6	17.7
103	L37	2.29	9.9	18.6
104	C13	3.35	17.5	27.5
105	L53	1.28	10.1	11.4
106	A1	0.86	7.7	9.5
107	F6	1.94	10.7	18.2
108	L53xL8	2.96	14.0	20.9
109	A1xL8	4.28	15.2	23.5
110	F6xL8	3.47	12.7	18.9
111	L53xL19	4.47	15.7	21.5
112	A1xL19	2.79	13.9	20.0
113	F6xL19	2.86	11.7	21.0
114	L53xL37	3.99	18.9	28.7
115	A1xL37	4.82	18.5	31.2
116	F6xL37	4.34	17.7	28.3
117	L53xC13	3.62	17.2	26.9
118	A1xC13	3.28	15.0	24.5
119	F6xC13	4.12	15.2	26.1
120	GWD2	4.10	18.4	30.1
LSD		0.96	4.0	3.5
C. V.		26.6	14.4	14.1
Mean		3.20	24.2	22.3

Table 3. Sugar percent by harvest dates. Seasonal accumulation rate study, Logan, Utah. 1976.

		Harvest		
		#1	#2	#3
Code	Description	Percent	Percent	Percent
101	L8	9.7	13.6	13.9
102	L19	9.6	16.0	16.6
103	L37	8.6	13.0	13.7
104	C13	8.4	11.9	13.7
105	L53	10.5	14.7	14.9
106	A1	9.3	13.4	13.1
107	F6	8.6	13.4	14.5
108	L53xL8	10.0	14.9	15.6
109	A1xL8	10.1	14.3	15.2
110	F6xL8	9.8	14.5	15.3
111	L53xL19	10.2	15.4	17.2
112	A1xL19	8.8	14.4	15.9
113	F6xL19	9.0	14.8	16.6
114	L53xL37	9.3	13.9	15.2
115	A1xL37	9.1	13.6	15.2
116	F6xL37	9.2	14.4	15.7
117	L53xC13	9.0	13.5	14.5
118	A1xC13	8.3	13.2	14.3
119	F6xC13	8.9	13.3	14.7
120	GWD2	8.7	13.8	14.7
LSD		0.9	0.6	0.9
C. V.		8.7	3.6	5.5
Mean		9.2	14.0	15.0

Table 4. Percent dry matter of roots and tops by harvest date. Seasonal accumulation rate study, Logan, Utah. 1976.

		Percent Dry Matter			
		Root		Top	
Code	Description	#1	#3	#1	#3
101	L8	15.9	25.3	11.3	16.3
102	L19	15.0	28.1	11.6	18.5
103	L37	14.9	25.9	10.9	17.3
104	C13	14.9	24.3	9.5	14.5
105	L53	15.7	26.0	11.1	15.8
106	A1	14.2	23.8	11.2	15.4
107	F6	14.2	25.3	10.5	13.8
108	L53xL8	16.2	26.7	10.1	16.3
109	A1xL8	15.8	26.4	9.9	14.7
110	F6xL8	14.8	26.7	10.5	15.7
111	L53xL19	15.8	27.6	9.8	15.8
112	A1xL19	14.0	26.9	9.9	14.7
113	F6xL19	14.1	27.1	10.0	16.2
114	L53xL37	14.3	26.0	9.0	15.2
115	A1xL37	14.1	26.0	8.5	14.0
116	F6xL37	14.4	26.0	9.7	14.5
117	L53xC13	14.3	25.5	8.8	14.3
118	A1xC13	13.9	24.7	9.0	13.9
119	F6xC13	14.2	24.6	9.4	14.2
120	GWD2	14.2	25.5	8.8	13.9
LSD		1.2	1.0	1.2	1.7
C. V.		6.8	3.3	10.7	9.7
Mean		14.7	25.9	10.0	15.2

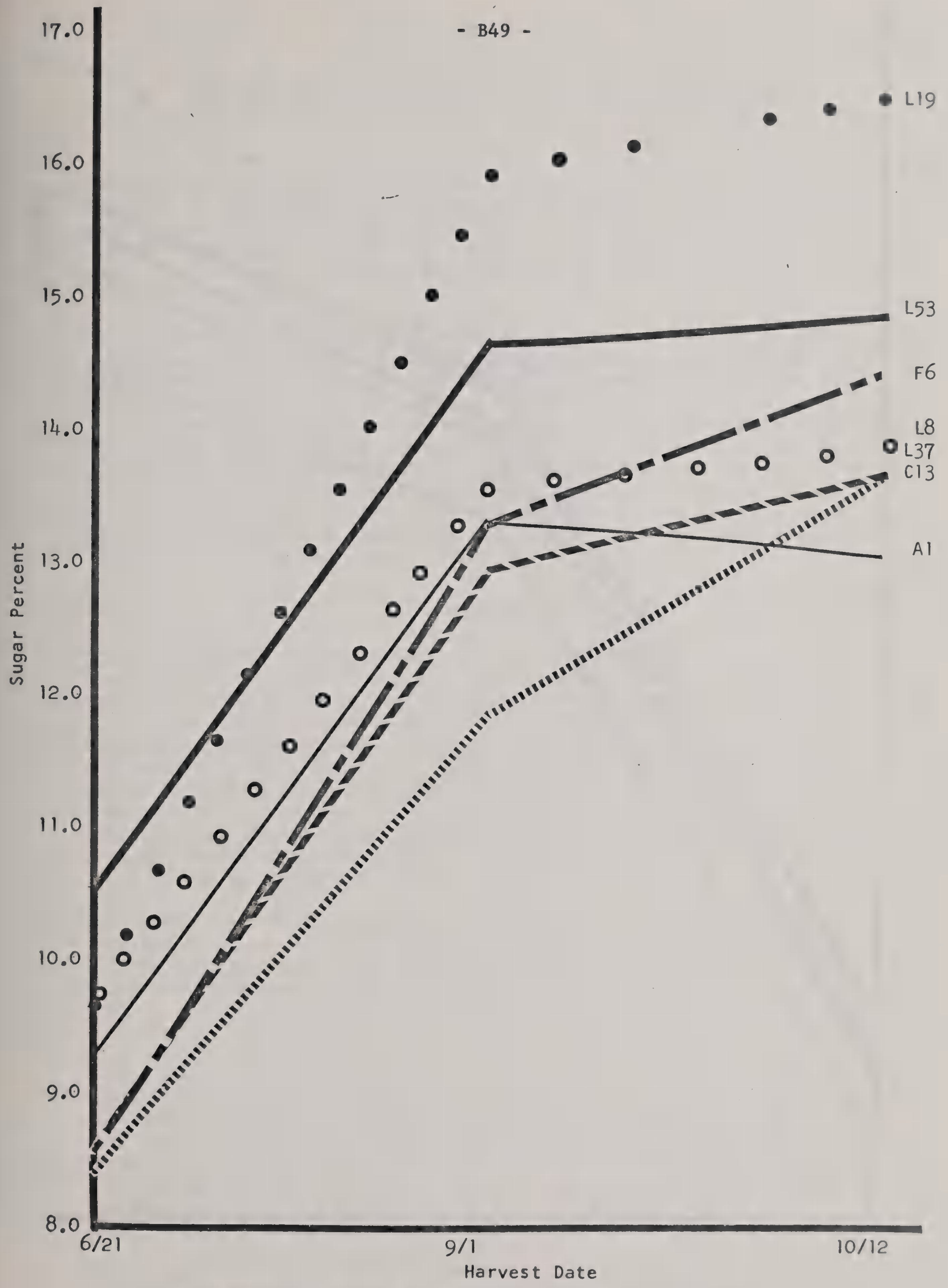

Fig. 1. Mean Sugar % of Inbreds

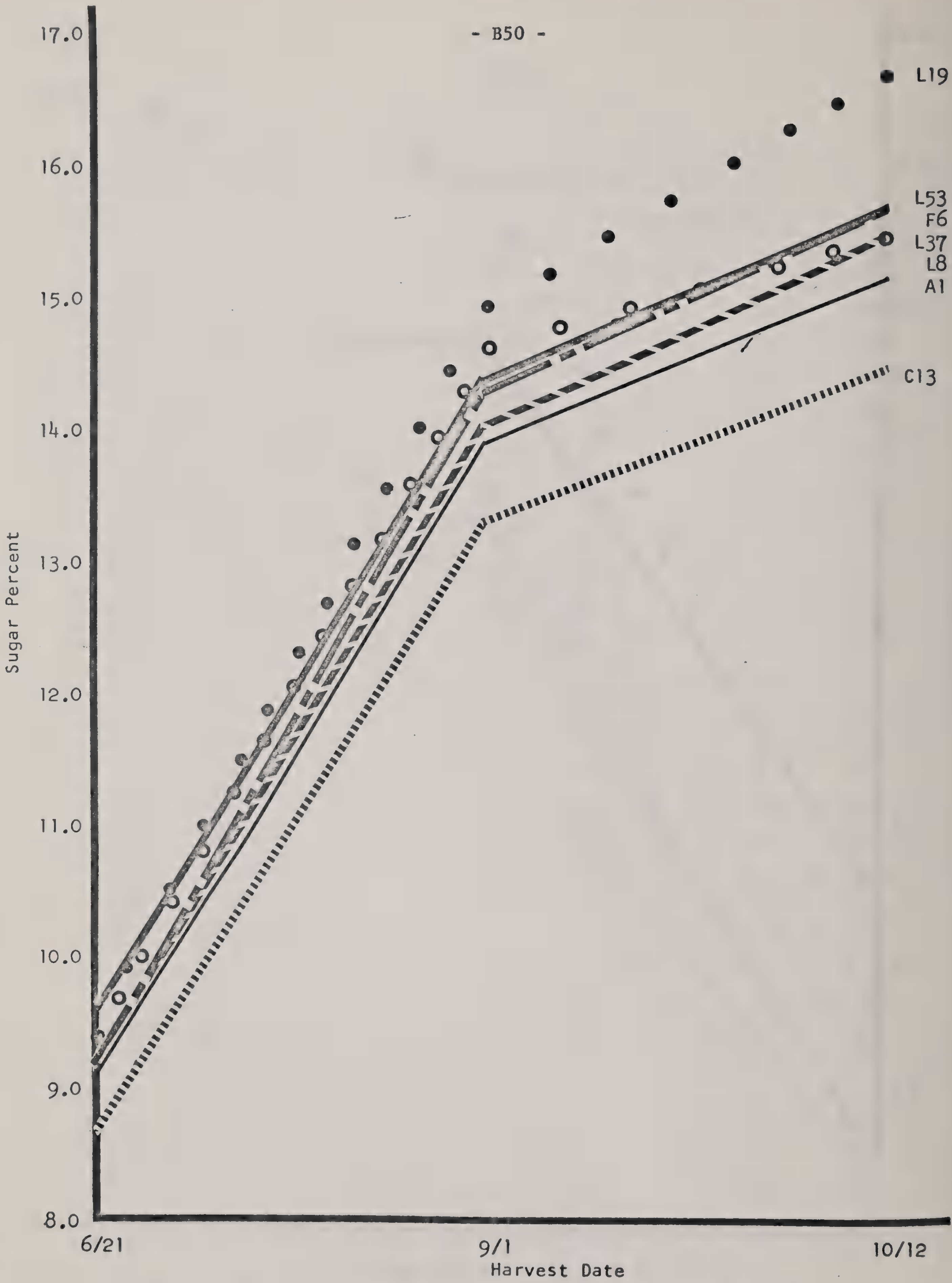

Fig.2. Mean Sugar % of Hybrids having indicated Inbred parent.

THE MECHANISM OF SUCROSE STORAGE IN THE SUGARBEET ROOT

Roger Wyse

The mechanism of sucrose storage in sugarbeet root cells is not known. Sucrose is translocated to the root via the phloem. Gieger has extensively studied the mechanism of phloem loading in leaf tissue and its location through the petiole to the root. The pathway of sucrose movement from the vascular tissue into the storage cells of the root has not been studied.

Sucrose movement into the root cells may be the step limiting sucrose accumulation. Inadequate rates of unloading the phloem tissue can slow photosynthate flow from the leaves. The result is decreased rates of photosynthesis. If the rates of unloading are adequate, the movement of sucrose into the vacuole may become limited. The concentration of sucrose in the vacuole approaches 0.75 Molar. Movement of sucrose from a low concentration in the free space into the high concentration in the vacuole thus requires considerable energy. Our present studies are concerned with this aspect of sucrose accumulation in the root; movement from the free space into the vacuole. The following are a few highlights of this past year's work.

METHODS

Disks of sugarbeet root tissue (0.5x5mm) are cut with a hand microtome and a sharp cork borer. The disks are then washed in running tap water for 30 minutes to remove sugars trapped in the free spaces (cell walls and intercellular spaces). The disks are then incubated at room temperature in 5mM PO_4 buffer containing the radioactively labeled sugar of interest. The solution is continuously aerated during incubation. After incubation for three hours, the disks are again washed in running tap water for 30 minutes to remove all sugars not actively stored in the vacuole. The disks are then extracted with hot 80 percent ethanol, and the amount of labeled sugar accumulated is determined by counting in a liquid scintillation counter.

Tissue used for autoradiography at the electron microscope level is treated in a similar manner except that after incubation the tissue is fixed in gluteraldehyde or Periodate-Lysine-Paraformaldehyde (PLP). Preparation for autoradiography is by standard techniques.

RESULTS

Using asymetrically labeled sucrose in the uptake studies, it was possible to ascertain whether sucrose moves from the free space into the vacuole intact, or whether it enters the cytoplasm is hydrolyzed and resynthesized before moving into the vacuole. If asymetrically labeled sucrose (glucose (C^{14})-fructose) is taken into the vacuole intact, all of the label should remain in the glucose moiety. If sucrose is hydrolyzed before moving into the vacuole, some of the label will appear in the fructose moiety.

The results of this experiment indicated two pathways of sucrose storage were operative (Table 1). The sucrose in the ethanol extract (the sucrose actively stored in the vacuole) contained counts in both glucose and fructose. The majority of the counts remained in glucose indicating that the principal mechanism of sucrose storage was via a non-hydrolyzing pathway; i.e., the sucrose moved from the free space into the vacuole without passing through the cytoplasm. However, a second pathway is also operating, as indicated by the counts in fructose, which results in sucrose movement into the cytoplasm where it is hydrolyzed. These results suggest that the non-hydrolyzing pathway must be a morphological feature that would allow passage of sucrose into the vacuole but prevent contact with cytoplasmic enzymes. If this were true, the feature should be visible with the electron microscope. A study of root cells from 4-month old sugarbeet roots showed such a morphological feature.

The storage cells of the sugarbeet root have a very thin cytoplasm and a very large vacuole (Figure 1). A distinctive feature is the vesicles which protrude into the vacuole. These vesicles allow the tonaplast and plasmalemma membranes to come into contact. The result is a passage from the cell wall into the vacuole that bypasses the cytoplasm. However, to prove that sucrose moves via this pathway, it was necessary to show that sucrose existed in the vesicles. To do this, the technique of autoradiography was utilized. This technique will detect radioactively labeled compounds in tissue at the EM level.

Results of this experiment (Figure 2) showed that sucrose-C^{14} taken up by the disks was found in vesicles still attached to the cell wall and also in vesicles which had pinched off and moved into the vacuole. After 30 minutes of washing, all counts remaining were found in these vesicles or in plastids containing starch (Figure 3). The counts found in starch were very surprising. There is very little starch found in the sugarbeet root, and, therefore, its active role in sucrose accumulation is surprising.

A survey of sugarbeet root cells indicated more starch containing plastids in cells near the vascular tissue and more vesicles in the parenchyma cells located near the center of the interring area.

Thus, our preliminary results indicate a unique mechanism of sucrose storage in sugarbeet root cells. This mechanism is similar to pinocytosis in lower organisms, and this is the first time it has been shown to exist in higher plants.

The incorporation of sucrose into starch before utilization in the cytoplasm or storage in the vacuole is difficult to explain. Currently in progress are experiments to determine the significance of this pathway, particularly in those cells near the vascular bundles.

Table 1. Redistribution of label in asymetrically labeled sucrose after its uptake into the vacuole of sugarbeet root cells.

	Glucose %	Fructose %
Sucrose (^{14}C - Glucose) before incubation	100	0
30 minute washings	93	7
Ethanol Extract	70	30

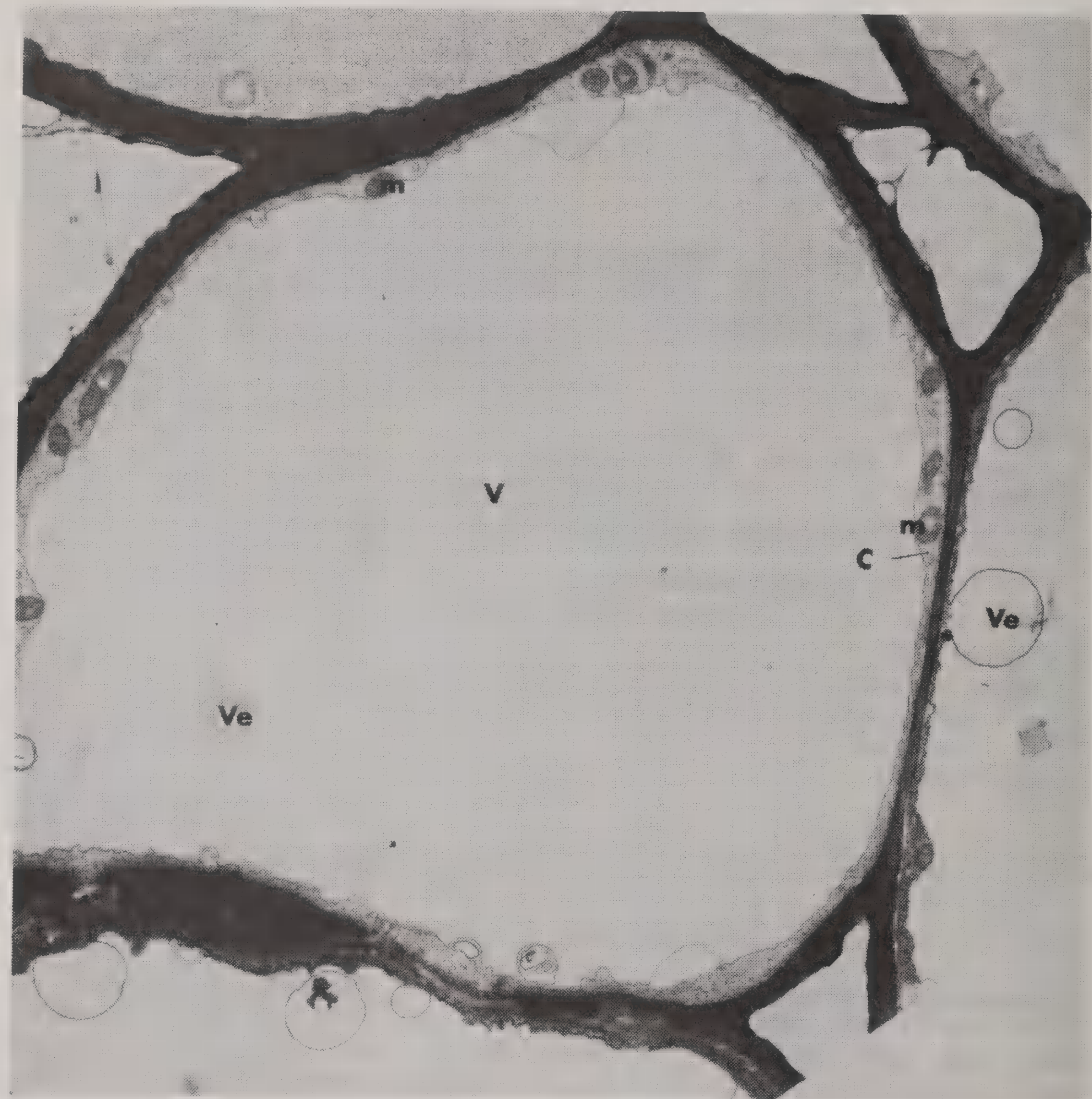

Figure 1. Sugarbeet root cell from near the center of the third ring. Note very narrow cytoplasm (c), huge vacuole (V), attached and free vesicles. Mitochondria (m) .

Figure 2. Vesicle (Ve) within a vacuole containing radioactive sucrose (wiggly lines).

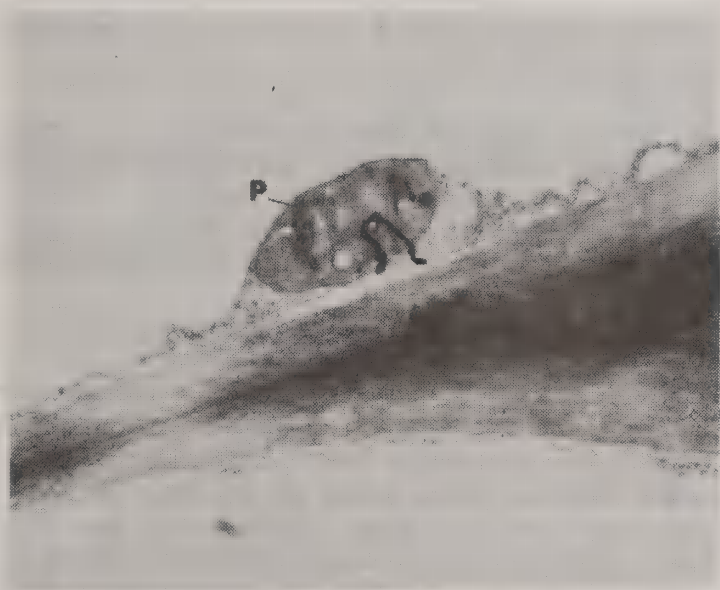

Figure 3. Starch containing plastic showing evidence of radioactive sucrose incorporation.

III. STORAGE AND RESPIRATION

A PRELIMINARY TECHNIQUE FOR MAXIMIZING THE UTILIZATION OF AMBIENT COOLING AIR DURING FORCED VENTILATION OF SUGARBEET STORAGE PILES

Roger Wyse

Cooling of sugarbeet storage piles as rapidly as possible after harvest is of primary importance if storage losses are to be minimized. In areas such as Michigan, Ohio, and the Intermountain Region, the ambient temperatures at harvest are marginal for rapidly cooling storage piles. Therefore, in these areas, it is particularly important to use what cooling air is available to its maximum advantage. The simulation model described in the previous article is an ideal mechanism for developing such a management guideline. Therefore, the model was used to develop the following technique for setting the thermostat of ventilation fans to optimize the use of cooling air available. Only the final result will be presented.

RESULTS

As air leaves the ventilation ducts and passes through the air spaces in a storage pile, two things happen:

1. Heat moves from the beets into the air.

2. Moisture moves from the roots into the air, increasing its relative humidity.

The result of heat moving from the beet to the air is a reduction of beet temperature until it approaches the ventilating air temperature. The result of water movement is evaporative cooling. This evaporative cooling lowers the beet temperature below the ventilating air temperature. This concept has been utilized in the following scheme.

Step 1. Determine the average pile temperature.

It is important to determine the average pile temperature by the following method if the technique is to work accurately: Place three thermometers through the vertical profile of a storage pile such that a thermometer is located at the center of the upper one-third of the mass of the pile, one in the middle one-third, and one in the center of the bottom one-third of the mass of beets. If this positioning is followed, the average pile temperature (the mean of the three thermometer readings) will be a true weighted average temperature.

Step 2. Determine wet and dry bulb temperatures.

The wet bulb and dry bulb readings can be taken any time when the temperature is between $\pm\ 10^{o}$ F of the pile temperature.

$$\frac{\text{Dry bulb} - \text{wet bulb}}{2} + \text{average pile temperature} = \text{temperature to set fans to turn on.}$$

These results indicate that normally fans should be set to turn on several degrees above the average pile temperature. Evaporative cooling will lower the effective cooling temperature to below that of the roots. Using this technique should add from one to several hours of cooling time each day. Over a two- to three-week period, this can result in significant cooling over the present method of turning the fans on at a set temperature or when the outside air is the same or less than the temperature at a single depth in the pile.

This method is still preliminary and should be used on an experimental basis only.

COMPUTER SIMULATION OF THE STORAGE OF SUGAR BEETS

Russell M. Holdredge and Roger Wyse

INTRODUCTION

In a typical year in the United States there are approximately 14 million tons of sugar beets placed in storage units of various types. The sugar loss during storage is dependent upon many factors which include beet variety, length of storage, beet temperature at time of storage, and ambient temperature during the storage period. The rate of sucrose loss, or respiration, is a function of temperature throughout the storage life and of time during the first several days after the beet is dug. To obtain an order of magnitude number for the potential sucrose loss during storage, 15 pounds of sucrose per ton of beets is assumed. This figure yields a possible loss of 200 million pounds of sucrose per year. Even if current pile management has reduced this figure by half, the loss is still of sufficient magnitude to be of considerable interest.

If sugar loss during storage is to be significantly reduced through improved pile management and the design of storage structures, additional information is needed concerning the heat transfer in a beet pile and the influence of cooling by free convection and by forced ventilation. A joint program between the Mechanical Engineering Department at Utah State University and the Sugar Crops Group of the Crops Research Laboratory of ARS in Logan, Utah, has been undertaken to supply this needed information by developing a model to simulate the thermal and physiological behavior of a beet storage pile. The model was programed for calculation on a high-speed digital computer. Some results of the preliminary version of the model were reported by Wyse and Holdredge (1975).

The problems associated with this thermal modeling of a beet pile are best depicted by examining some unanswered questions associated with the pile, with an individual root, or with a section of the pile. For the pile some of the concerns are:

1. Is meaningful information obtainable from a one-dimensional model?

2. What is the impact of omitting end-effects?

3. How is the heat transfer from the top of a pile modeled?

4. What is a realistic assumption for the temperature of the beets in contact with the ground?

In examining a single beet, one might raise the following questions:

1. How is the shape of a beet described mathematically?

2. What is the relationship between respiration, time, and temperature?

3. What is the temperature variation in a beet?

4. What is the convection model for energy exchange between the beet and the air?

5. How do we model the freezing of a beet?

6. How do we account for the water loss from the beet?

Finally, if a section out of the pile is examined, the problems are:

1. How is conduction between the beets modeled?

2. What is the temperature and air variation through the section?

3. How does the presence of other beets in various orientations influence the convection model?

The work of other investigators gives some insight into these problems, but answers few questions. For example, the literature of Schalit (1965) did not directly address any of these problem areas of concern. The work of Villa (1973) gave some help in understanding how an individual beet behaves. Also efforts in modeling potato storage were examined, Hylmö (1975) for example. The work on potato storage helped provide a general understanding of the behavior of a beet pile but did not help in answering the specific concerns raised earlier.

The objective of this paper is to report on the progress to date in developing the beet storage simulation model. The experimental observations that have been utilized are reviewed. The mathematical details of the model are presented. A comparison of calculations and experimental results is presented and some potential uses of the model in pile management are given. For this preliminary work, a one-dimensional model was assumed. The results of this effort will then be the major factor in deciding whether a two- or three-dimensional model is needed or justified.

EXPERIMENTAL BACKGROUND

In order to obtain a better understanding of the ventilation of a beet pile, preliminary tests were conducted on a small pile which was set up to simulate a section of a large pile. Four major factors were observed:

1. For most pile and inlet air combinations there was no observable difference in temperature between the beet root and the air immediately adjacent to it.

2. A cooling front was observed to pass through the pile as a wave.

3. Except when the beet is cooled or heated at a rapid rate, the temperature variation in the beet is small.

4. The beets at the bottom of the pile showed considerable dehydration. Air temperatures approached the air wet bulb temperature within 6" to 12" of the bottom of the pile. Measurement of relative humidity also confirmed the cooling air becomes saturated within a short distance after entering the pile and remains saturated as it moves upward through the pile.

THE MODEL

The differential equation describing the temperature variation in the pile was derived by considering a section of the pile between two horizontal planes. The bottom plane is at some arbitrary elevation x above the ground, and the upper plane is at an elevation $x + \Delta x$. The rate of energy added to the section by conduction and bulk fluid movement (convection) at the lower surface on a per unit area basis is

$$\left(-k_E \frac{\partial T_B}{\partial x}\right)\Bigg|_x + \left(p_A u c_A T_A\right)\Bigg|_x$$

The energy per area leaving is

$$\left(-k_E \frac{\partial T_B}{\partial x}\right)\Bigg|_{x+\Delta x} + \left(p_A u c_A T_A\right)\Bigg|_{x+\Delta x}$$

Where $\big|_x$ or $\big|_{x+\Delta x}$ indicates the quantity is being evaluated at x or at $x+\Delta x$. The rate of change of energy of the section under consideration per unit area is

$$\left(p_B c_B \frac{\partial T_B}{\partial t} + p_A c_A \frac{\partial T_A}{\partial t}\right)\Delta x$$

The rate of energy release per unit volume by respiration is Q''' and per unit area is $Q''' \ \Delta x$. An energy balance then yields

$$\left(p_B c_B \frac{\partial T_B}{\partial t} + p_A c_A \frac{\partial T_A}{\partial x}\right) = Q''' + \frac{\left(-k_E \frac{\partial T_B}{\partial x}\right)\Big|_x - \left(k_E \frac{\partial T_B}{\partial x}\right)\Big|_{x+\Delta x}}{\Delta x} + \frac{\left(p_A u c_A T_A\right)\Big|_x - \left(p_A u c_A T_A\right)\Big|_{x+\Delta x}}{\Delta x}$$

If $\Delta x \to 0$ and the basic definition of the derivative is employed, the resultant differential equation is

$$p_B c_B \frac{\partial T_B}{\partial t} + p_A c_A \frac{\partial T_A}{\partial x} = Q''' + k_E \frac{\partial^2 T_B}{\partial x^2} - p_A u c_A \frac{\partial T_A}{\partial x} .$$

Next the results of the preliminary experiments are reconsidered. Based upon the first observation, an equilibrium model is assumed, or more precisely, at any location and any time $T_A = T_B = T$. The second observation indicates conduction between the beets may be insignificant. Preliminary calculations show the convection term is typically on the order of 20 or more times the conduction term. Thus, the second assumption is the conduction is negligible. Finally, in any element the energy change of the air is negligible compared to the energy change of the beet or

$$p_A c_A \frac{\partial T}{\partial t} << p_B c_B \frac{\partial T}{\partial t}$$

The final differential equation is

$$p_A c_A u \frac{\partial T}{\partial x} + p_B c_B \frac{\partial T}{\partial t} = Q''' \qquad (1)$$

where Q''' is a function of time, t, and temperature, T.

The initial condition or initial pile temperature is generally not easily described by a simple mathematical function. The boundary condition of the inlet air temperature is also difficult to depict in a simple fashion. These two factors, when coupled with a desire to allow Q''' and the inlet velocity, u, to vary, made a numerical solution very attractive. Several attempts to solve equation (1) numerically resulted in problems with stability or oscillations in the results unless exceptionally small time elements were used. The present scheme might be described as forward difference in space and backward difference in time and to date no stability problems have been observed.

Experimental observation number 4 presents a challenge in modeling. In addition, most existing experimental data does not include relative humidity or wet bulb temperature information. The specific heat c_A was taken as an effective specific heat of saturated air, or the values assigned to $c_A \Delta T$ in any calculation account for the energy change of the air and the water vapor plus the energy involved in vaporizing the water absorbed from the beets as the air is warmed.

This procedure neglects the cooling effect due to the initial saturating of the incoming air. This latter effect is, however, much less than the cooling accounted for by using the effective specific heat. Also an effective compensation, as noted by Wyse and Holdredge (1975), is to use the air wet bulb temperature, if available, as the inlet air temperature.

The model can be effective in predicting beet pile behavior only if the respiration is known and adequately represented in the model. The respiration data reported by Wyse (1976) was fitted by the method of least squares to the equations

$$R_1 = C_1 \exp(B_1 t + A_1 t)$$

and

$$R_1 = C_2 \exp\left(\frac{B_2}{t} + A_2 t\right).$$

The equation which best represents the respiration in the time period under consideration is then selected in making the calculations.

COMPARISON WITH EXPERIMENTAL RESULTS

Figures 1 through 7 present the comparison of the prediction of the model and experimental data supplied by Utah-Idaho Sugar Company. It should be noted that all elevations are feet above ground level. The results from the 10 cfm/ton rate of cooling are especially good. For the 20 cfm/ton ventilation rate there is good agreement except for the 18-foot level. Part of the problem at this 18-foot level may be with the initial temperature variation which was used in the model prediction. In this case, the initial variation was based upon data from only three pile points. If this profile had placed the cooling front nearer the 12-foot level, the agreement at the 18-foot level would be better since the cooling front would have passed at a later time. For the 40 cfm/ton cooling rate, the agreement is good except for the time period 9 to 10 days.

Figure 8 gives the variation of the ventilation air temperature. No data was available for two time periods, one near 6 days and the second near 8 days. The arbitrary values used in the simulation are shown. There is also a possibility that the ventilation fans were not in operation during the warm period near day 9; however, in making the simulation, it was assumed the ventilating fans were in operation. The final reduced data from Utah-Idaho Sugar Company indicates the ventilation rates of 20 cfm/ton and 40 cfm/ton used in the simulation are probably 10% high.

In conclusion, the comparison of experimental and simulated results indicates the model is surprisingly effective in predicting pile behavior.

USE OF THE MODEL IN PILE MANAGEMENT

Figures 9 and 10 are only two of an almost unlimited number of comparisons that could be made for use in pile management. These figures indicate the importance of initial pile temperature, cooling air temperature and ventilation rate on sugar loss. The effective pile temperature, a parameter which is generated by the model, could also be included in the comparison. Another example of use of the model would be to develop criteria to be used in answering questions such as

1. For specified air temperature and pile temperature variation, should the ventilation fans be on or off?

2. If the pile should be ventilated, what is the most effective ventilation rate?

Only time and experience with using the simulation will yield the most effective use of the results in beet pile management.

FUTURE PLANS FOR THE MODEL

Several improvements in the model are currently in the planning process. These include the ability to handle the freezing of beets, accounting for pile geometry, modeling the energy transfer for the non-ventilated pile, improvements in the respiration equations, including a non-equilibrium model for the case of rapid pile cooling, and improvement in the treatment of the energy transfer from the top and side surfaces.

ACKNOWLEDGMENTS

The financial support of the Beet Sugar Development Foundation made this effort possible. Also the author would like to thank Utah-Idaho Sugar Company for supplying the data which made it possible to compare the results with actually measured temperatures.

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NOMENCLATURE

c_A Effective specific heat of saturated air

c_B Specific heat of beet root

k_E Effective thermal conductivity of the beet root

t Time

T Temperature

T_A Temperature of the air

T_B Temperature of the beet root

u Average air velocity in the pile

x Elevation, measured from ground level

p_A Density of air

p_B Density of beet

Q''' Energy release by respiration per unit volume

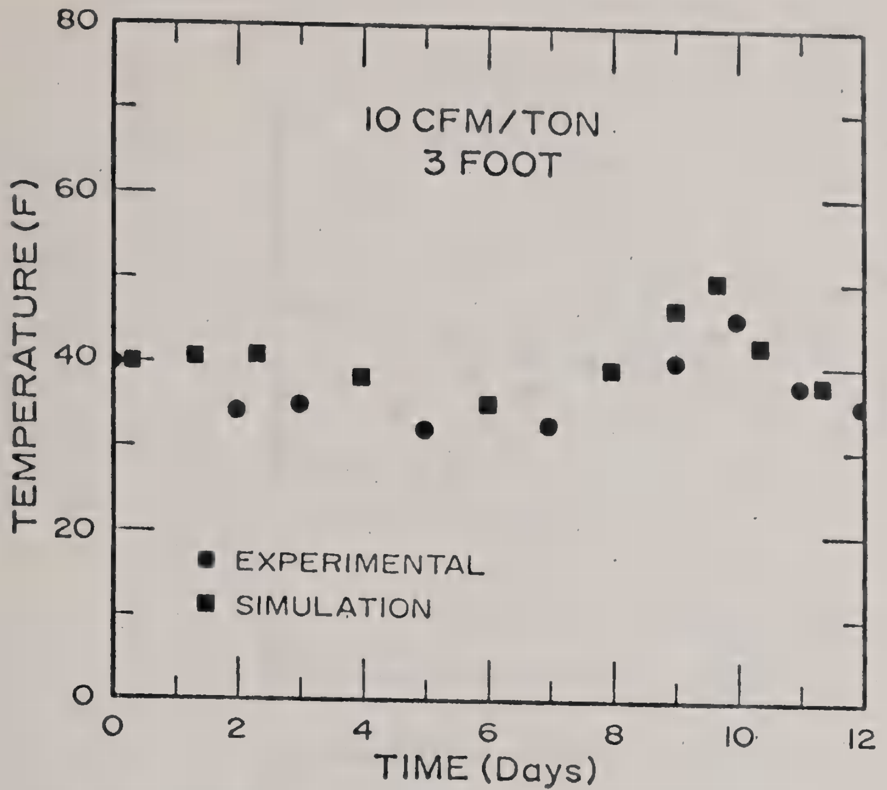

Fig. 1. Comparison of experiment and simulation for 10 cfm/ton ventilation at 3 foot elevation.

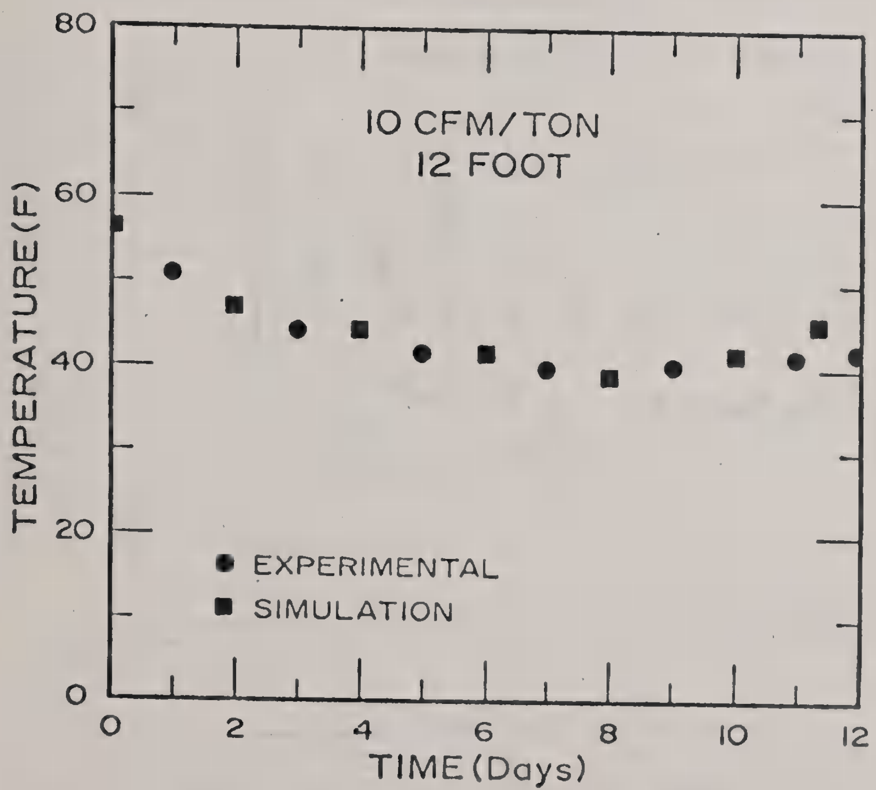

Fig. 2. Comparison of experiment and simulation of 10 cfm/ton ventilation at 12 foot elevation.

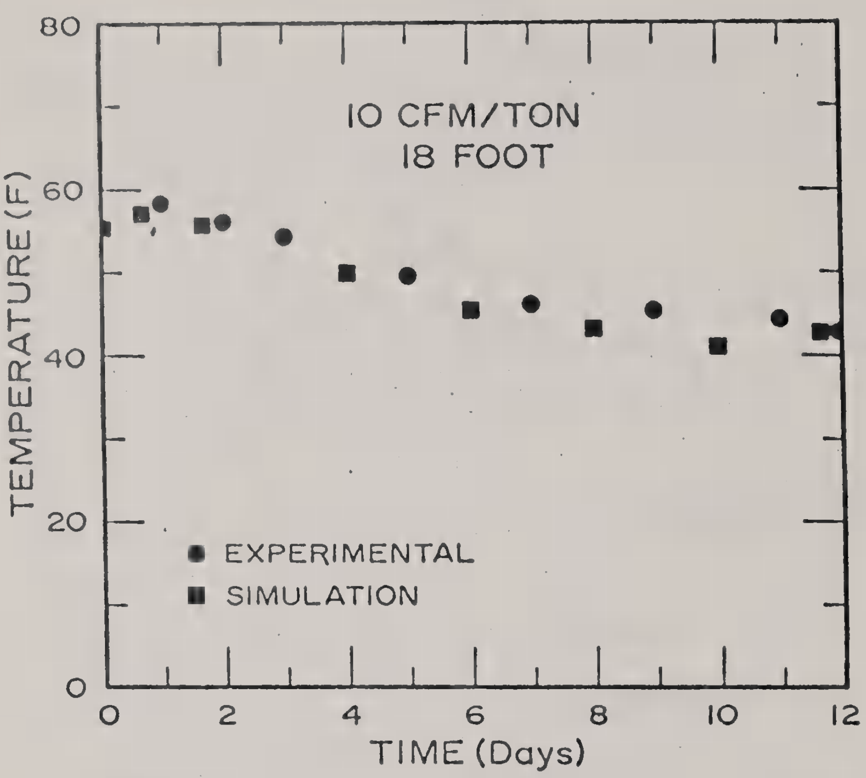

Fig. 3. Comparison of experiment and simulation for 10 cfm/ton ventilation at 18 foot elevation.

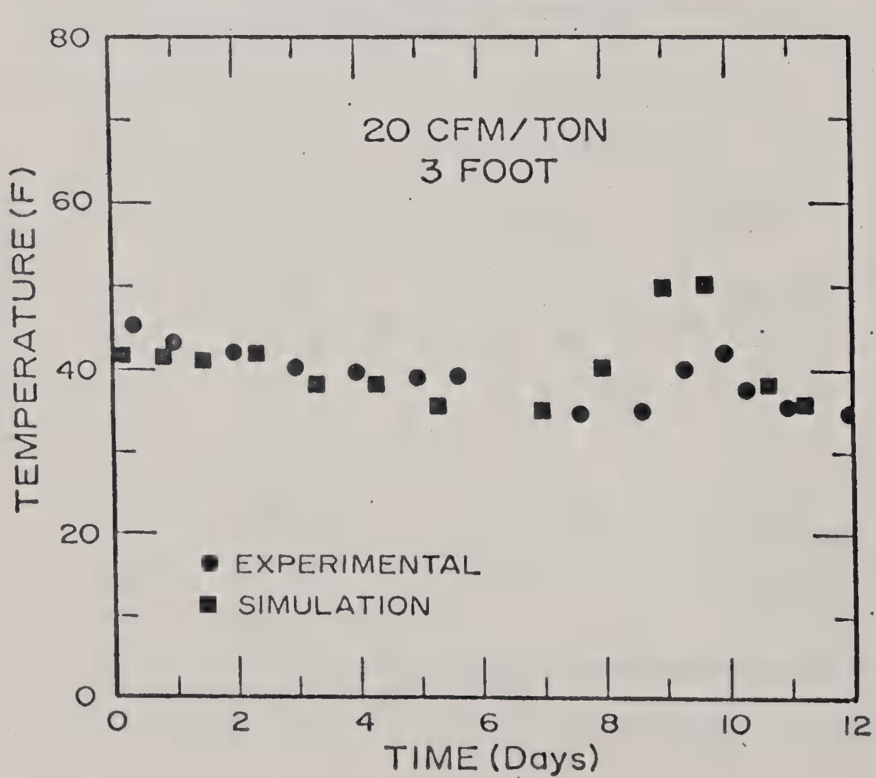

Fig. 4. Comparison of experiment and simulation for 20 cfm/ton ventilation at 3 foot elevation.

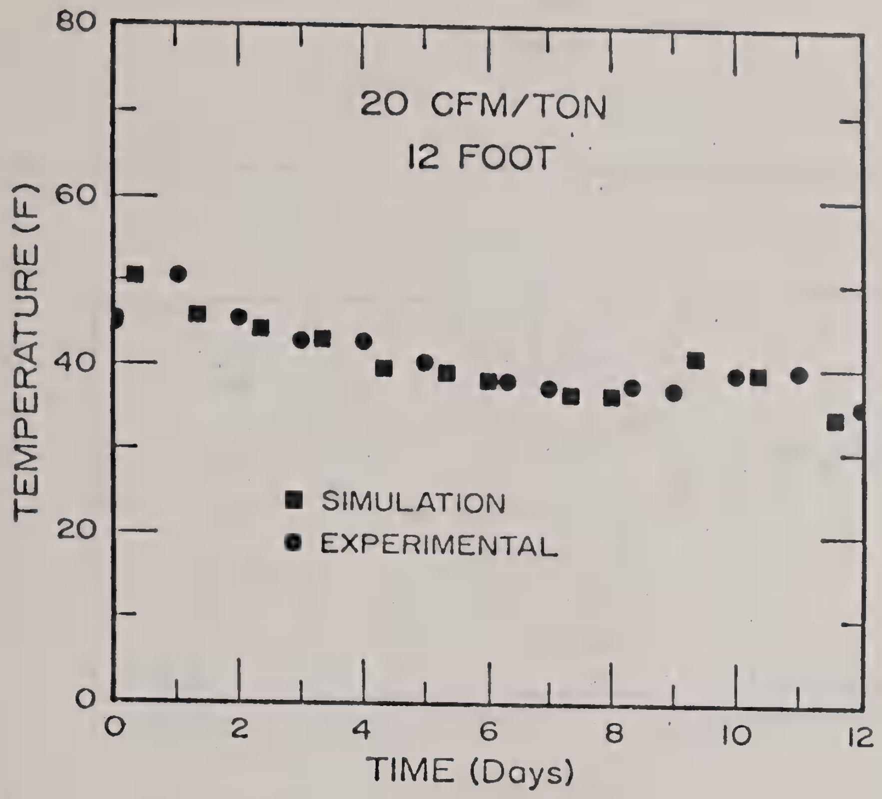

Fig. 5. Comparison of experiment and simulation for 20 cfm/ton ventilation at 12 foot elevation.

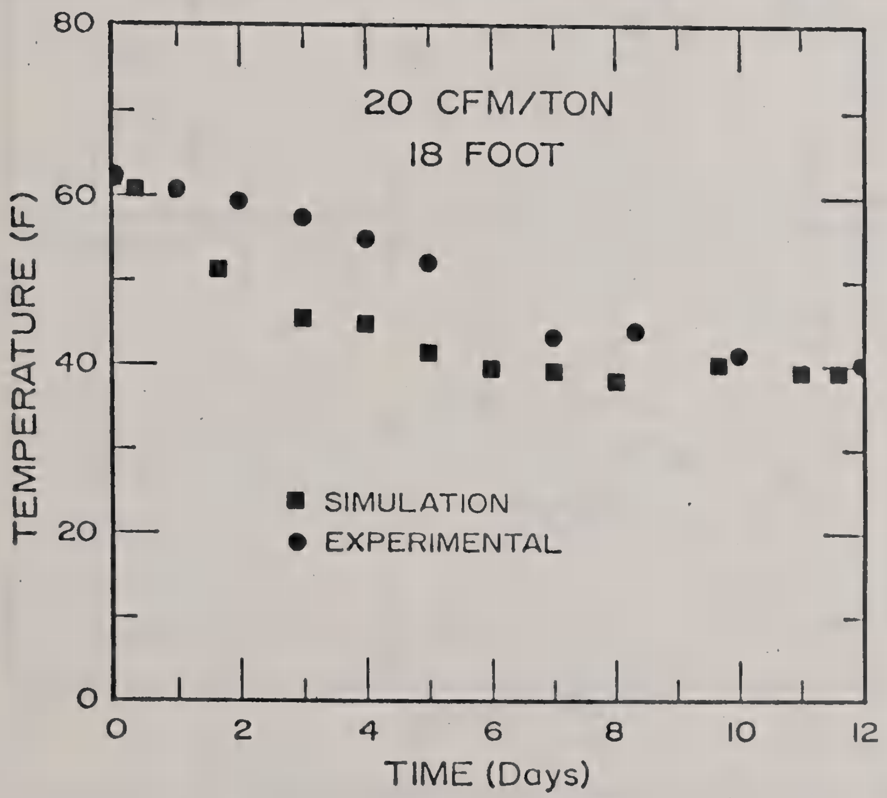

Fig. 6. Comparison of experiment and simulation for 20 cfm/ton ventilation at 18 foot elevation.

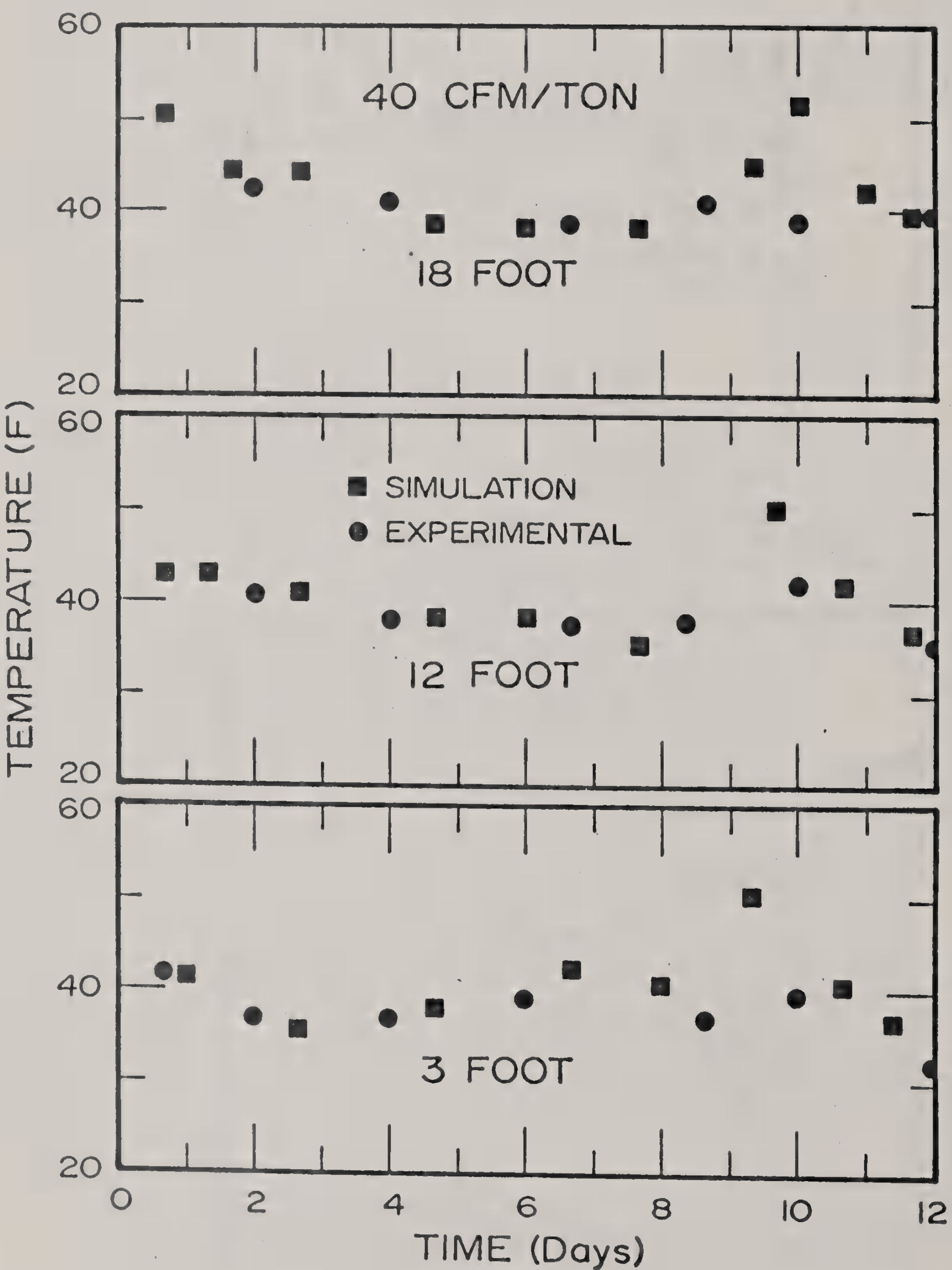

Fig. 7. Comparison of experiment and simulation for 40 cfm/ton.

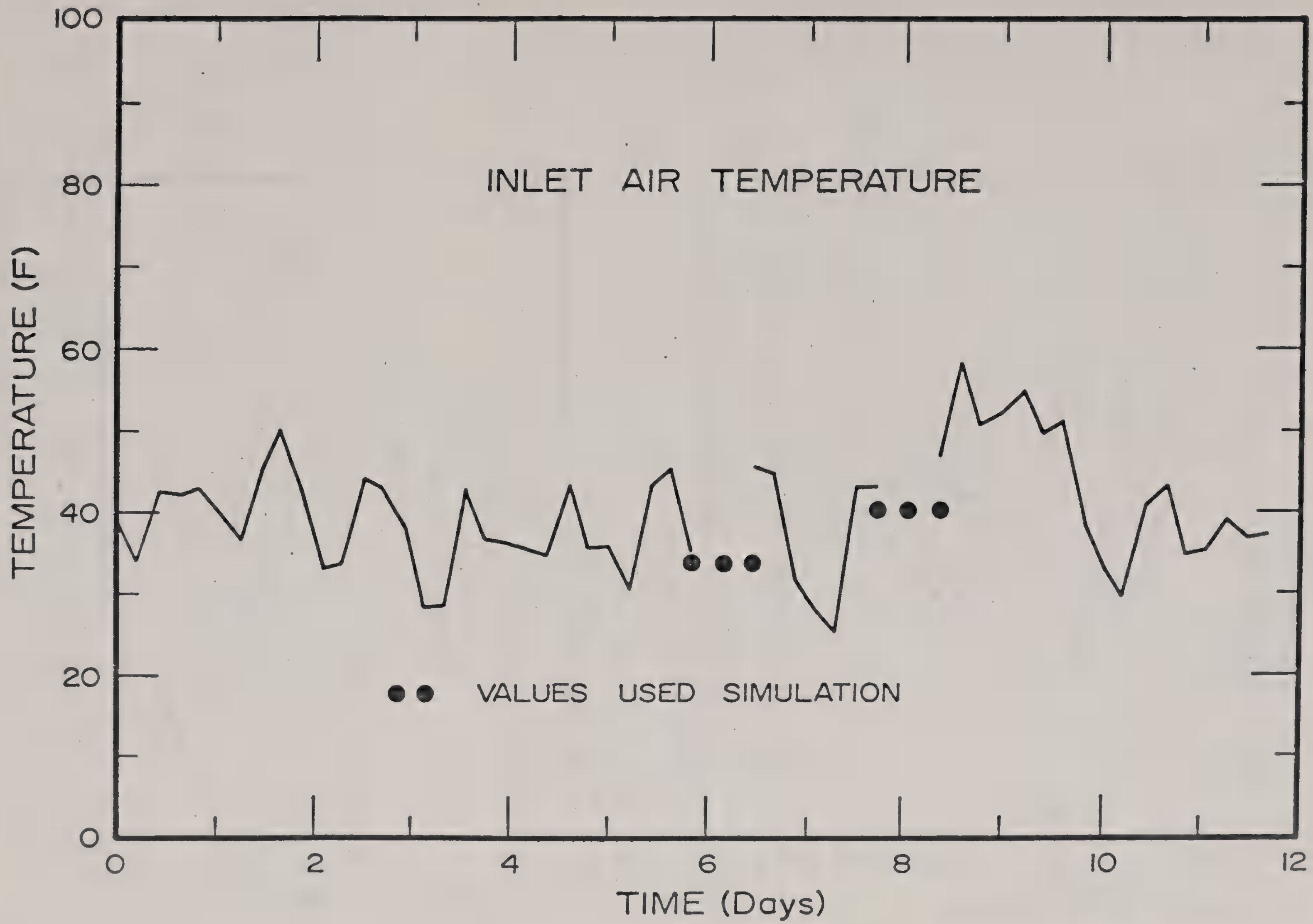

Fig. 8. Inlet air temperature.

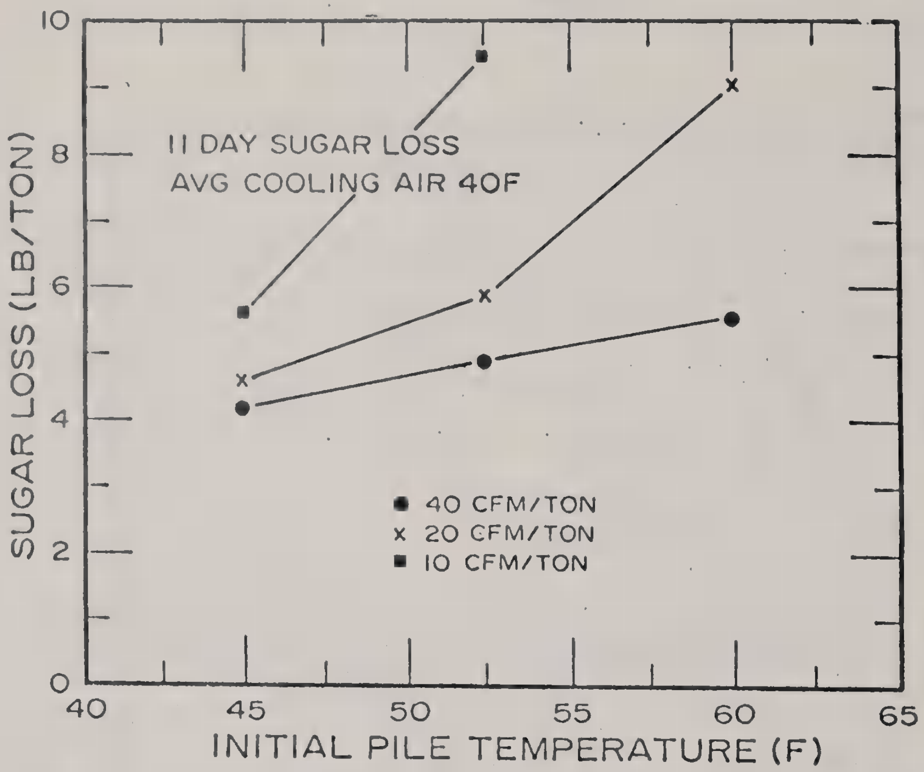

Fig. 9. Influence of pile temperature and cooling rate on sugar loss.

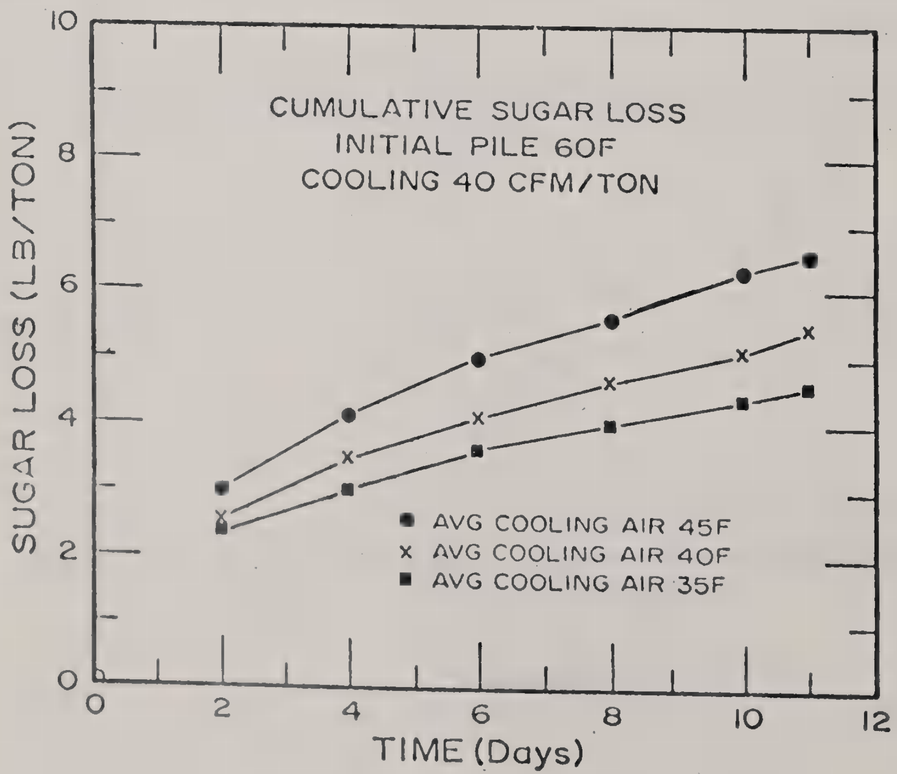

Fig. 10. Influence of cooling air temperature on sugar loss.

IV. INSECT RESISTANCE STUDIES

EVALUATION AND SELECTION FOR ROOT MAGGOT RESISTANCE

Carl C. Blickenstaff, J. C. Theurer, and D. L. Doney

Ten inbred lines of sugar beet showing differences in root maggot populations in 1974 and damage ratings in 1975 were rated again in 1976 under a much higher maggot infestation. In addition, crosses between some inbreds rated high, medium or low damage in 1975, an inbred check, a hybrid check, a commercial variety and two broad-based populations were included in the test. The 33 entries were randomized in eight replicates. Seed was planted by hand in ten "hill" single rows with spacings of 12 inches in the row and 22 inches between rows. Seedling plants were thinned to one per hill. Perfect stands were not obtained and varied from 2.6 to 9.5 plants per entry at the time of rating. Some reduction in stand was caused by the sugar beet root maggot, but most was due to poor germination, planting too deeply, or both. All surviving plants were dug on July 14-15 and rated for damage on an 0 = none to 5 = severe scale. Average plant height per plot was recorded on June 4, about the time of peak fly activity.

Selections from the first cycle of a recurrent selection study were also evaluated in 1976. Seed was produced at Logan, Utah, from mother roots selected for high and low damage in 1975. The amount of seed available was rather limited. Plots of low (L) and high (H) selections were seeded in three 10-foot side-by-side rows. These were compared with single-row plots of the 25A1 original parent, an inbred check, and a hybrid check. Plots were randomized within eight replicates. Seeds were planted by hand in hills one foot apart within the rows on April 27 and later thinned to one plant per hill. Average height per plot was recorded on June 4 at the time of peak fly activity, and the plants were rated for sugar beet maggot damage July 16.

Results

There were significant differences for height and mean damage ratings by root maggots for inbreds (Table 1). L29 and L35 were rated low in damage during all three years. Entries 89 and AN039 have rather consistently rated high in damage. The mean damage in 1976 was greater than in 1975 for all entries. There was a high rank correlation (r = 0.89) for the damage rating of the inbreds during the two years if L19 was excluded.

The correlation between plant height and damage rating for the inbred lines using the averages for each line was 0.46 ns (n = 10); when lines L89 and L29 were omitted, the correlation was 0.92** (n = 8). Plant height significantly influenced the damage rating.

Inbred L29, although relatively tall at peak fly activity, was rated very low for damage and was tentatively classed as resistant. On the other hand, inbred L89 was only moderately tall but had the highest average damage rating and was tentatively classed as most susceptible to damage. Hybrids of low, medium, and high maggot damaged inbreds tended to have a damage rating near that of the mid-parent (Table 2). Low x low hybrids gave low damage, while hybrids having a high-damage parent were highest in root damage.

Progeny of plants selected for high root maggot damage in 1975 sustained the highest average damage in 1976 (Table 3). They were also the smallest at time of fly activity and had the poorest stand: this could be due to less vigor, greater damage, or a combination of the two.

Progeny of plants selected for least damage in 1975 had significantly (1% level) less damage than those selected for high damage.

The original parent was intermediate between H and L for height, stand, and maggot damage.

These data (Tables 2 and 3) demonstrate that selection and breeding for low maggot damage are effective.

Table 1. Height anddamage rating for sugar beet root maggots on inbreds at Kimberly, Idaho, 1974 - 1976.

Identity	Avg. No. Plts./ Rep.	Plt. Hgt. 6/4 Inches	1976 Mean Damage Rating	1975 Damage Rating	1974 No. SBRM Per Plt.
L29	4.2	2.48	1.82	1.06	0.6
L35	4.7	1.52	1.93	.62	0.6
L32	4.1	1.88	2.12	1.03	4.3
LRf1	3.5	1.67	2.17	1.11	2.6
L37	7.4	2.08	2.26	1.32	9.9
EL39	3.1	2.43	2.33	1.23	0.8
L53	4.4	2.00	2.35	1.28	5.0
L28	6.5	2.22	2.38	1.30	11.1
AN039	7.3	2.78	2.63	1.34	15.6
L89	5.0	2.30	2.79	1.37	15.6
L19 Inbred	4.4	2.34	2.65	1.01	2.3
1166 Hybrid Check	6.0	2.88	2.40		
25A1 Rec. Sel. Broad-base	6.3	1.59	2.50		
25A2 Rec. Sel. Broad-base	5.6	2.00	2.59		
UI-8	9.1	2.63	2.55		
LSD .05			0.67		

Table 2. Sugarbeet root maggot damage ratings for crosses between lines rated for low and high damage in 1974 and 1975. Kimberly, Idaho, 1976.

Identity	Avg. No. Plts./Rep	Plt. Hgt. 6/4/76 Inches	1976 Mean Damage Rating	Mid-Parent
Low x Low Cross:				
L35 x L29	7.8	2.22	2.19	1.88
Low x Medium Crosses:				
L53 x L29	5.3	3.03	2.01	2.09
L35 x L53	5.9	2.59	2.35	2.14
Medium x Medium Cross:				
L53 x L37	6.5	3.00	2.11	2.31
Low x High Cross:				
L29 x L89	4.0	2.66	2.38	2.31
Medium x High Cross:				
L37 x L28	4.5	2.19	2.34	2.32
L.S.D.			0.67	

Table 3. Recurrent selection for resistance to the sugarbeet root maggot. Kimberly, Idaho, 1976.

Seed Entry	No. Plants Rated	No. Plants % of Perfect Stand	Plt. Hgt. (in.) at Peak Fly	Damage 1/ Rating
Low Damage 1975 Selections	194	80.8	1.95	2.325
High Damage 1975 Selections	136	56.7	1.80	2.818
Original Parent 25A1	60	75.0	1.91	2.428
L19 Inbred Check	49	61.2	2.41	2.310
1166 Hybrid Check	66	82.5	2.56	2.549
LSD				0.370

1/ Plants were rated individually on a scale of 0=no damage to 5=severe damage.

SUGARBEET RESEARCH

1976 Report

Section C

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Colorado State University Experiment Station

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CONTENTS

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 1976

GASKILL, J. O. and ROBERTO EHRENFELD K. Breeding sugarbeet for resistance to yellow wilt. J. Am. Soc. Sugar Beet Technol. 19(1):25-44. 1976.

Conclusive evidence was obtained in field tests of 1972-73 and 1973-74 at the Estación Experimental La Platina, near Santiago, Chile, that measurable progress had been made in breeding sugarbeet for resistance to yellow wilt. The level of resistance attained thus far in breeding lines is not high, but the evidence strongly indicated that further progress can be made. The results suggested the existence of useful sources of resistance, other than the sugarbeet.

The general failure of selected, diseased plants to produce seed after transplanting has been a serious obstacle in the breeding work. Results obtained in 1973 indicated that relatively satisfactory seed yields can be obtained from such plants with the aid of repeated treatments with the antibiotic, Terramycin.

In early selection and breeding for yellow wilt resistance in Argentina and Chile, it was concluded that plants without symptoms of the disease at the end of the vegetative growth period, under severe yellow wilt exposure, were simply escapes and consequently of little or no value for resistance breeding purposes. Evidence presented in this report indicated that, for at least some of the current breeding material, such plants may possess genes for resistance and should not be excluded from the breeding program.

HECKER, R. J. and E. G. RUPPEL. Rhizoctonia root-rot resistance in sugarbeet: breeding and related research. Accepted for publication in J. Am. Soc. Sugar Beet Technol.

Losses from root rot of sugarbeet (*Beta vulgaris*) caused by *Rhizoctonia solani* are increasing in several U.S. beet production areas. A program of breeding for resistance has resulted in slow but continuous improvement of resistance. After inoculation, infection is effectively resisted by up to 70% of the plants in the most resistant breeding lines, compared to 0 to 5% in commercial hybrid varieties. Partial dominance for resistance has been demonstrated in experimental hybrids. Two generations of backcrossing was only slightly effective for incorporation of resistance into a susceptible genotype. The effect of selection solely for resistance did not drastically reduce the genetic variance for sucrose yield components. The interaction of genotype X fungus strain was not found to be of practical significance. The resistant breeding lines have been resistant to *R. solani* isolates in several locations in the United States and Japan.

HECKER, R. J. Quantitative genetic and breeding methods in sugarbeet and other crops. Accepted for publication in Proc. Pickling Cucumber Improvement Comm. Meeting, 1976.

Genes conditioning quantitative characteristics in plants cannot be precisely described or manipulated in a direct manner. Breeders of quantitative characters must rely on applied statistics to learn about genetic control of the character of interest. Three general methods of analysis

have considerable applicability in plant breeding. The factorial method of genetic analysis is a subqualitative method of discovering the genetic control of relatively simply inherited quantitative characters. The partitioning of variance components tells the breeder the types of gene action conditioning a character. The diallel analysis method allows comparisons of general and specific combining ability in different breeding families or lines. All three of these methods help the breeder determine the type of genetic control conditioning specific characteristics such as yield, plant height, quality characters, disease resistance, etc. From this genetic information the breeder is better able to decide the most effective breeding method to use for improvement of the character or characters of interest.

HECKER, R. J. and E. G. RUPPEL. Registration of diploid and tetraploid FC 701/4 and FC 703 sugarbeet germplasm. Accepted for publication in Crop Sci.

The diploid and autotetraploid forms of FC 701/4 and FC 703 sugarbeet were developed by the ARS, USDA, in cooperation with the Beet Sugar Development Foundation and the Colorado State University Experiment Station. All the lines are multigerm and moderately resistant to Cercospora leaf spot, and they have relatively little bolting resistance.

FC 701/4 is a product of two cycles of recurrent selection for Rhizoctonia resistance following four cycles of mass selection from GW 674.

FC 701/4 (4X) is the C_3 colchicine-induced autotetraploid of FC 701/4.

FC 703 is a product of two cycles of recurrent selection for Rhizoctonia resistance from FC 702 X FC 701. These parents had been developed by four cycles of mass selection from C 817, a high-production synthetic from an adapted open-pollinated variety, and GW 674, respectively.

FC 703 (4X) is the C_3 autotetraploid of FC 703.

In field tests over 3 years, these lines exhibited the greatest resistance to a highly virulent root-rotting strain of *Rhizoctonia solani* and to all other root-rotting and damping-off strains of *R. solani* to which they were exposed. At harvest, 40 to 65% of the roots were healthy, compared to 0 to 6% of the roots of commercial varieties. As pollinators, these lines showed varying degrees of partial dominance for resistance. The tetraploids, when used as pollinators, imparted an additional increment of resistance to some resulting hybrids. In the absence of disease, the sugar yield of these lines was below that of commercial varieties. These lines can be used as pollinators in hybrid seed production or as a source of resistant germplasm.

RUPPEL, E. G. and S. J. PETERSEN. Effect of benomyl on in vitro and in vivo biology of benomyl-tolerant strains of *Cercospora beticola*. Approved by ARS for publication in J. Am. Soc. Sugar Beet Technol.

Increased concentrations of benomyl in vitro inhibited growth of two benomyl-tolerant strains of *Cercospora beticola*, but had little effect on conidial production. Viability and length/width (L/W) ratios of conidia produced in vitro tended to decrease with higher concentrations of benomyl, dependent upon the fungus strain. Increasing the benomyl rate applied to

sugarbeet tended to decrease disease severity, sporulation, conidial viability, and L/W ratios of conidia of tolerant strains. The adverse effects of benomyl on growth processes were less pronounced on the most tolerant strain. Disease severity incited by both tolerant strains was reduced equally at each higher concentration of fungicide. The limited degree in which increased benomyl concentrations inhibited growth and disease severity of tolerant strains indicated that continued use of benomyl in the field would not eliminate these strains from the indigenous fungal population.

RUPPEL, E. G. and B. J. TOMASOVIC. Epidemiological factors of sugar beet powdery mildew. Accepted for publication in Phytopathology.

Susceptibility to powdery mildew (*Erysiphe polygoni*) in sugarbeet inoculated 2, 4, 8, 12, and 16 weeks after planting increased with plant age. Of 33 plant species representing 19 genera in nine families, only *Beta atriplicifolia, B. lomatogona, B. macrocarpa, B. macrorhiza, B. maritima, B. patula, B. trigyna,* and *B. vulgaris* (red beet, sugarbeet, Swiss chard) were highly susceptible to the fungus from sugarbeet; *B. patellaris* was highly resistant. Atypical infection spots occurred on senescent leaves on one *Chenopodium capitatum* and two *Rumex crispus* plants, but the hyphae did not spread, sporulation was minimal or nonexistent, and the fungus ultimately disappeared. Powdery mildew conidia (Erysiphe spp.) from *Amaranthus retroflexus, R. crispus,* and *Solanum sarachoides* growing in sugarbeet fields did not infect sugarbeet in the greenhouse. Vegetative mycelia or conidia of the fungus remained infectious in sugarbeet leaf debris buried outdoors in soil for 60 but not 90 days. Infected leaf debris stored at room temperature, in a refrigerator at 3-4 C, or in a protected area outdoors over winter was noninfectious when tested after 60 days storage. *E. polygoni*-infested seed yielded healthy seedlings, and inoculum prepared from infested seed was noninfectious to sugarbeet. The brief life of the fungal vegetative stage, the absence of the perfect stage, specificity for the genus *Beta*, and the yearly sequential spread of the disease support the theory that overwintering of the fungus mainly occurs in the southwest from where conidia are carried northward and eastward by prevailing winds.

SMITH, G. A., S. S. MARTIN, and K. A. ASH. Path coefficient analysis of sugarbeet purity components. Accepted for publication in Crop Sci., March-April issue, 1977.

A detailed analysis of the association of ten chemical and agronomic characters with purity in three sugarbeet (*Beta vulgaris* L.) genotypes was used to develop models to identify the components having the greatest effect on purity.

Potassium, betaine, and sodium followed by nitrate nitrogen, amino nitrogen, and sucrose were the most important variables in the 12 best models developed to explain purity. R^2 values (percentage of ascribed variation in purity) for these 12 best models ranged from 89.5 to 94.7%. Soluble non-sucrose constituents increased in quantity from high plant population density to low density, but this linear change did not greatly affect models constructed to account for juice purity either at regular or low nitrogen fertility.

SMITH, G. A. and S. S. MARTIN. Effects of plant density and nitrogen fertility on purity components of sugarbeet. Accepted for publication in Crop Sci., May-June issue, 1977.

The influence of plant density and nitrogen fertility level on purity, sucrose content, and eight other chemical components affecting purity were examined in a 2-year field study of three sugarbeet (*Beta vulgaris* L.) cultivars. There were significant differences among cultivars for all analyzed characters in one or both years. Between the two nitrogen levels, raw juice concentrations of ash, total N, amino N, nitrate, betaine, sodium, and potassium were greater, and chloride, sucrose, and purity lesser under regular N than low (residual) N, though the differences were not always statistically significant. Impurities generally decreased with increasing plant density, and differences among the four densities were significant for most components in both years. These differences were largely, but not solely, due to differing amounts of nitrogen per plant. Of the three main effects analyzed, plant density and cultivar were followed by soil nitrogen level with respect to effect on the ten variables measured, and very few first or second order interactions were detected.

Published Papers Abstracted in Sugarbeet Research, 1975 Report

HECKER, R. J. and E. G. RUPPEL. Polyploid and maternal effects on rhizoctonia root rot resistance in sugarbeet. Euphytica 25:419-423. 1976.

QUALITY AND BREEDING RESEARCH

Effects of Plant Density and Nitrogen Fertility on Purity Components.--G. A. Smith and S. S. Martin.

A two-year study was conducted to determine the influence of plant density, nitrogen level, and cultivar on chemical components affecting juice purity. A preliminary report of one year's data appeared in the 1974 Sugarbeet Research Report. Three cultivars (GW Mono Hy D2, Holly HH-21, and FC 702/4) were field-grown in 1974 and 1975 at two nitrogen fertility levels (R = Regular = 114 kg/ha N as ammonium nitrate; L = Low = no applied N) and four plant population densities (118,900; 59,450; 29,700; and 19,800 plants per hectare). Soil tests indicated residual nitrogen of about 45 kg/ha in 1974 and 70 kg/ha in 1975.

Means for purity and nine chemical characters affecting purity are summarized in Table 1, averaged for 1974 and 1975. The trends shown by these averages are essentially identical to those shown by the data in each separate study year. Characters showing significant differences from a main effect or 1st- or 2nd-order interaction were not consistent in both study years. The low frequency of significant interactions was especially striking because of the known disparity for agronomic and chemical characters of the three cultivars studied.

Excluding sucrose and purity, within each nitrogen level the component concentration for each genotype was usually inversely proportional to plant density. For example, potassium means for cultivar I under low N and decreasing plant densities were 103, 110, 117, and 134 mg/100 ml, respectively; under regular N the corresponding values were 109, 118, 128, and 141 (Table 1). At a given N level, the amount of N present per plant decreases with increasing plant density, so it was possible the inverse proportionality observed between purity component magnitudes and plant population density might be an effect of the availability per plant of nitrogen, the only major nutrient applied, rather than of plant density. To examine this possibility, we calculated component means across genotypes at the eight levels of nitrogen initially present per plant (i.e., at each of the eight plant density and nitrogen level combinations) (Table 2). The sum of residual nitrogen plus applied fertilizer nitrogen was taken as a satisfactory approximation of the nitrogen initially available per unit area, although it must be recognized that all factors of the nitrogen cycle (including the rates of nitrogen fixation, nitrification, leaching, mineralization, and crop growth) affect the amount of nitrogen actually available to a plant at a given time.

If all component concentration changes resulted from nitrogen supply alone, in Table 2 one should see both increasing component means with increasing nitrogen per plant, and similar component concentrations at nitrogen-density combinations that resulted in nearly equal amounts of nitrogen per plant. Correlation coefficients confirm the general fulfillment of the first of these requirements, as only chloride means were not significantly correlated with nitrogen initially present per plant. Purity and sucrose, as many previous studies have shown, were strongly negatively correlated with nitrogen per plant.

At the pair of initial N levels R-3 and L-1 (Table 2) the amount of nitrogen per plant was almost identical, but the plant population density at R-3 was three-fold that at L-1. Concentrations of the nitrogenous components amino N, nitrate, and total N were nearly the same or slightly lower at the lower density, whereas the nitrogen-containing betaine and non-nitrogenous inorganic compounds were present in higher concentrations in the sugarbeets grown at the lower plant density. Presumably plants at the lower density had less competition for the fixed amount of inorganic compounds present, and thus accumulated more of these compounds than did plants grown at the higher density. The accumulation of nitrogenous compounds (except betaine) seemingly was more affected by nitrogen present per plant and less by plant density, yet the important effect of plant density is shown in Table 3. At each of the four plant densities studied, the change in component magnitude per gram increase in initial nitrogen level per plant is tabulated. This rate of change was greatest at the highest density for every component except potassium, for which the rate was slightly higher at the second highest density.

The data of tables 2 and 3 demonstrate that altered chemical component concentrations at different plant densities are affected by but are not solely due to level of N per plant. Coefficients of determination (r^2) calculated from the correlation coefficients of Table 2 suggest that 60 to 92% of the variability of each character's means may be explained by variability in nitrogen initially present per plant. The remainder must be due to other factors, including plant density. Many factors such as moisture and nutrient availability, leaf canopy size and light utilization,

Table 1. Summary of means[1] for 9 characters and purity for 3 cultivars at 4 plant densities and two nitrogen levels.[2]

		Plant per hectare							
		118,900		59,450		29,700		19,800	
	Cultivar[3]	Low N	Reg. N	Low N	Reg. N	Low N	Reg. N	Low N	Reg. N
Amino N	I	30.9	35.7	31.9	35.9	35.7	35.9	35.3	38.3
	II	31.2	35.1	30.4	35.5	33.4	37.4	31.7	37.1
	III	31.0	37.3	34.8	39.0	33.5	38.7	35.8	41.7
Nitrate	I	15.6	17.9	16.4	24.9	23.8	23.5	24.1	28.9
	II	34.4	36.3	30.9	39.7	37.5	44.7	29.3	45.5
	III	11.4	19.4	15.2	22.3	14.5	23.0	24.9	29.8
Total N	I	122.4	143.0	120.9	140.5	145.2	137.6	135.9	153.1
	II	135.9	137.5	119.9	148.1	145.2	149.8	127.8	156.9
	III	134.3	162.6	154.7	151.9	144.6	166.3	160.8	166.2
Betaine	I	314.3	316.4	313.7	327.2	355.8	343.2	332.0	361.1
	II	314.0	335.9	328.0	355.2	335.7	375.9	361.3	376.9
	III	332.3	342.7	352.9	353.4	343.8	364.3	365.9	403.7
Sodium	I	26.3	31.5	28.9	30.4	37.7	33.2	37.5	36.6
	II	42.2	39.7	43.9	49.7	50.6	53.9	53.4	54.9
	III	23.7	31.3	29.5	34.9	28.9	40.2	36.1	43.9
Potassium	I	103.3	109.1	109.7	118.0	117.3	128.3	133.9	141.2
	II	111.7	119.4	116.3	127.9	135.4	146.6	137.8	146.2
	III	113.5	111.8	114.5	126.3	118.4	128.7	129.4	140.9
Chloride	I	6.6	6.4	9.3	7.6	13.4	11.8	16.9	13.9
	II	10.3	8.8	13.5	13.7	22.8	18.9	26.5	21.1
	III	7.9	7.2	9.1	9.2	12.5	11.0	14.6	13.7
Ash	I	393.6	418.1	410.3	431.6	455.9	465.0	475.8	494.1
	II	465.4	477.9	465.3	514.7	536.3	557.8	531.6	566.9
	III	403.7	422.8	415.0	456.6	426.6	458.8	479.1	518.6
Purity	I	95.5	95.3	95.2	94.7	94.4	94.9	94.9	94.3
	II	95.2	94.6	94.9	94.0	94.7	93.3	94.1	93.4
	III	95.4	94.5	94.9	94.7	95.2	94.7	94.1	92.8
Sucrose	I	17.2	17.0	17.3	16.9	17.1	16.8	17.1	16.6
	II	17.0	16.7	17.2	16.6	16.8	16.0	16.7	16.1
	III	17.7	17.1	17.6	17.1	1.75	16.9	16.9	16.3

[1]Means presented are the average of 1974 and 1975 experiments.

[2]Values for sucrose and purity are in %, whereas values for other characters are in milligrams/100 ml of raw juice.

[3]Cultivars I, II, and III = GW Mono Hy D2, Holly HH-21, and FC 702/4, respectively.

and temperature fluctuations in the microenvironment differ with plant densities, affecting both growth and accumulation of impurity components.

Table 2. Character means[1] arranged according to increasing nitrogen initially present per plant, and correlation coefficients between character means and nitrogen per plant.

	Grams nitrogen per plant								Correlation
	0.48	0.97	1.44	1.94	2.88	2.90	5.77	8.66	coefficient
Character	L-4[2]	L-3	R-4	L-2	R-3	L-1	R-2	R-1	r
Amino N	31.0	32.4	36.0	34.2	36.8	34.3	37.3	39.0	0.84**
Nitrate	20.5	20.8	24.5	25.6	28.9	26.1	30.4	34.7	0.94**
Total N	130.9	131.8	147.7	145.0	146.8	141.5	151.2	158.7	0.85**
Betaine	320.2	331.5	331.7	345.1	345.3	353.0	361.1	380.6	0.96**
Sodium	30.7	34.1	34.2	39.1	38.3	42.3	42.4	45.1	0.86**
Potassium	109.5	113.5	113.4	123.7	124.0	133.7	134.5	142.8	0.91**
Chloride	8.3	10.6	7.5	16.2	10.2	19.3	13.9	16.2	0.52
Ash	420.9	430.2	439.6	472.9	427.1	467.2	454.0	505.5	0.77*
Purity	95.36	95.00	94.80	94.76	94.46	94.36	94.30	93.50	-0.94**
Sucrose	17.30	17.36	16.93	17.13	15.87	16.90	15.85	15.71	-0.85**

[1]Sucrose and purity are in percent. All other characters are in mg/100 ml raw juice (presentation as mg/100 g sucrose would simply accentuate the trends shown).

[2]Nitrogen-density code. Nitrogen: R = Regular = 171 kg/ha; L = Low = 57 kg/ha. Density: 4, 3, 2, 1 = 118,900; 59,450; 29,700; and 19,800 plant/ha, respectively.

*,**Values of 0.707 and 0.834 required for significance at 5% and 1% levels, respectively.

Means for ash, total N, amino N, nitrate, betaine, sodium and potassium were greater, though not always significantly so, at regular N than at low N (Tables 1 and 2), whereas chloride behaved oppositely and seemed associated primarily with plant density rather than N level. The correlation coefficient between chloride content and initial nitrogen per plant was not significant (Table 2), and at levels R-3 and L-1, where N per plant was almost identical, average chloride content at the lower density was almost twice that at high density. In contrast, there was much less difference in chloride content at any fixed density, despite regular N or low N conditions. The other important anion analyzed, nitrate, was significantly correlated with initial nitrogen level. The ratio of nitrate to chloride, calculated at each plant density to remove the large influence of this variable on chloride, was always greater in plants grown under regular N than those under low N (Table 4). The increased ratio at regular N must arise from a combination of the slight depression of chloride content (Table 2) and a greater

increase in nitrate content in plants grown under regular N. The important effect of plant density on chloride uptake is illustrated by the consistent decrease in nitrate to chloride ratio with decreasing density within each nitrogen column. The decreasing ratios must result from the greater chloride content at lower plant densities, becasue nitrogen present per plant and therefore juice nitrate concentrations increase within each column as plant density decreases. More chloride ions than nitrate ions are accumulated at lowest density and no applied nitrogen (low N), whereas almost two nitrate ions are accumulated per chloride ion at highest density and regular N application. These data appear to suggest that chloride may be preferentially accumulated relative to nitrate, and that as chloride available per plant is limited by increasing plant density, nitrate is accumulated in greater proportion.

Table 3. Change at four plant population densities in component concentration per 1.0 gram increase in initial nitrogen level per plant.

	Plant density (plants/ha)			
Character	118,900	59,450	29,700	19,800
Amino N	5.2	2.2	0.81	0.38
Nitrate	4.2	4.2	1.3	1.0
Total N	17.5	7.9	1.6	2.1
Betaine	12.0	7.2	4.2	4.8
Sodium	3.6	2.2	0.86	1.2
Potassium	4.1	5.5	2.8	3.3
Chloride	- 0.83	-0.21	-0.60	-0.54
Ash	19.5	-1.6	-4.9	6.6

Table 4. Effect of plant density and nitrogen fertility level on nitrate to chloride ratio in sugarbeet raw juice extracts.

	NO_3^- to Cl^- ratio*	
Plants per hectare	Regular N	Low N
118,900	1.87	1.41
59,450	1.62	1.12
29,700	1.25	0.90
19,800	1.22	0.77

*Ratio calculated from data in meq/liter raw juice.

Comparisons of Raw Juice and Thin Juice Purity.--R. J. Hecker and S. S. Martin.

Laboratory thin juice has been for many years the standard (albeit imperfect) for purity in research programs. It replaced raw juice purity which was widely used prior to the development and modification of the thin juice method by Brown and Serro, and Carruthers and Oldfield. Inadequate work has been done on the relationship of thin juice and raw juice purity and the sucrose and nonsucrose components of each. Following are some observations relative to this problem.

In Table 1 are listed 10 cultivars and 4 juices extracted by different means. Cultivar 358 was a sugarbeet-fodderbeet hybrid, and 362 was a fodderbeet. The other cultivars are current and obsolete varieties, and experimental hybrids. The standard thin juice process was used. The raw juice extract refractive dry substance (RDS) was determined by a direct refractometer reading. The extract was then lead defecated and the polarization read in an optical saccharimeter.

Table 1. Cultivars and juices, and their effects on fresh brei sucrose and thin juice purity.

Entry or juice no.	Cultivar or juice	Sucrose (%)	Thin juice purity(%)	Extract purity(%)
353	US H9B	14.6 c[1]	95.1 a[1]	92.0[2]
354	US H20	13.9 d	95.4 a	91.7
355	HH 10	15.4 ab	94.9 a	91.5
356	GW 359	15.6 a	95.6 a	91.4
357	GW Mono Hy Al	15.9 a	95.7 a	92.3
358	52-305 CMS X Ovana	11.5 e	91.8 b	87.1
359	3-way exp. hybrid	15.9 a	95.7 a	92.1
360	52-307 CMS X 54-346, F_1	14.7 c	96.0 a	92.2
361	52-305 CMS X 52-307, F_1	14.9 bc	95.8 a	91.8
362	Ovana (fodderbeet)	7.6 f	83.5 c	78.0
I	1:1 (W:W) brei extract; immediate analysis	7.1 b[3]	93.2 c	90.1
IV	1:1 brei to boiling water extract; samples frozen prior to purity anal.	7.1 b	91.4 b	88.2
VI	1:1 brei to water extracted with juicerator; samples frozen prior to purity anal.	7.0 b	96.9 a	89.0
VII	1:1 extract from frozen brei; juicerator	7.5 a	93.0 c	80.0

[1]Means within the same column and group followed by the same letter are not significantly different ($\alpha = 0.05$).

[2]Extract purities of cultivars are for juice I.

[3]Sucrose content of the 1:1 extracts.

Table 2. Correlations of thin juice and raw juice purities within different cultivars and juices (number of pairs in parentheses).

Entry	Juice				All
	I	IV	VI	VII	juices
353	0.64 (20)**	0.73 (14)**	0.80 (10)**	0.35 (16)	0.63 (60)**
354	0.62 (19)**	0.47 (15)	0.62 (7)	0.74 (17)**	0.62 (58)**
355	-0.08 (18)	0.30 (16)	0.73 (9)*	0.44 (17)	0.57 (60)**
356	0.25 (19)	0.19 (13)	0.67 (7)	0.35 (17)	0.33 (56)*
357	0.37 (16)	0.35 (15)	0.64 (8)	0.35 (17)	0.46 (56)**
358	0.68 (18)**	0.85 (15)**	0.60 (11)*	0.86 (16)**	0.75 (60)**
359	0.57 (18)*	0.48 (18)*	0.12 (7)	0.22 (18)	0.39 (61)**
360	0.68 (19)**	0.64 (15)*	0.53 (6)	0.50 (16)*	0.56 (56)**
361	0.66 (19)**	0.54 (18)*	0.46 (10)	0.44 (17)	0.51 (64)**
362	0.84 (17)**	0.85 (11)**	0.92 (5)*	0.91 (13)**	0.87 (46)**
All entries	0.92(183)**	0.90(150)**	0.88 (80)**	0.90(164)**	0.90(577)**
All entries except 358 & 362	0.48(148)**	0.52(124)**	0.57 (64)**	0.45(135)**	0.53(471)**

The correlations of raw 1:1 extract and thin juice purity are shown in Table 2. The total correlation across all cultivars and juices is 0.90. Within juices the correlations are similar and relatively high, but within cultivars the correlations are quite dissimilar with the highest correlations occurring for the fodderbeet (entry 362) and the fodderbeet hybrid (entry 358). This indicates a closer correspondence between raw 1:1 extract and thin juice purities in low quality beets. The last line of Table 2 shows the relatively low correlations within juices when these two low quality entries were excluded.

In a more recent experiment we found the correlation to be only 0.32** between undiluted expressed raw juice and thin juice purities. The means in this experiment are shown in Table 3. The raw juice purity was much more variable than thin juice purity, although the variances of the purity components were not significantly different (Table 3). Hence, the significantly different variances of the two purities must have arisen through the combination of dissimilar RDS and sucrose components. This possibility is reinforced by the fact that the correlation was only 0.32.

As part of our research on beet quality assessment, we have in progress additional studies on the relationship of raw juice and thin juice purities.

Table 3. Comparison of variances of raw juice and thin juice purities, and their components (Experiment 1, 76).

Character	Mean		Variance[1]		
Thin juice purity	93.08	**	0.943	**	
Raw juice purity	85.21		8.011		
Thin juice RDS	11.58	**	0.380	NS	
Raw juice RDS	16.69		0.443		
Thin juice pol sucrose	-- [2]		0.060	NS	*
Raw juice GLC sucrose	14.23	*	0.053	NS	
Fresh brei sucrose	14.41		0.038		

[1]Last three variances (for sucrose) are in standard units.

[2]Not possible to convert to sucrose on fresh weight basis.

Comparison of aluminum chloride and lead subacetate clarification of normal weight sugarbeet brei extracts. I. Sucrose determination by polarimetry.-- S. S. Martin.

Clarification of normal-weight sugarbeet brei extracts with aluminum chloride (1.0 gram anhydrous salt per liter) was compared with the standard lead acetate clarification. Eighty samples were obtained from field-grown plants of 8 experimental hybrids. Each sample was analyzed by both procedures, which were identical except for the solution added. Sucrose content was determined with a Thorn-NPL Type 243 automatic polarimeter.

Lead-clarified and aluminum-clarified samples had polarimeter sucrose means and standard deviations of 14.41 ± 0.95 and 14.39 ± 1.01, respectively. The correlation coefficient (r) between the two sample types was 0.987, and a paired sample t-test indicated no statistically significant difference between the sample types [$t = 0.801$ ns; $t_{0.05}$ (df 79) = 1.98]. Thus the aluminum clarification procedure is satisfactory for pol sucrose determinations on normal weight extracts, with the primary advantage relative to lead being aluminum's non-toxicity to humans and to other organisms potentially affected by waste disposal. In addition, aluminum chloride is readily soluble in water and solutions are easily prepared. However, the anhydrous salt should be handled with care and its solutions prepared in an efficient hood, as the salt reacts with water with violence and liberation of considerable heat.

An examination of the equivalence of the lead-clarified and aluminum-clarified filtrates for analysis of sodium, potassium, chloride, nitrate, amino N, total N, and betaine is in progress.

Results of Two Cycles of Reciprocal Recurrent Selection in Sugarbeet.-- R. J. Hecker.

For a number of years, I have been carrying on a reciprocal recurrent selection study in order to evaluate the breeding method as a means for improvement of sugarbeet. Two cycles have now been completed. In theory, reciporcal recurrent selection should result in the accumulation of genes with superior additive effects and of genes which interact to produce superior performance. We have demonstrated in previous experiments that both additive and non-additive gene action are important in sugar yield, especially in the case of root yield. Hence, the breeding method should be useful for developing improved sugarbeet genotypes.

In the study, the source A population was Am. #2 Mono, a monogerm, open-pollinated, high sucrose, high purity variety (now obsolete) from the American Crystal Sugar Company (not adapted in northern Colorado). Source B was GW-359, an adapted multigerm open-pollinated variety (now obsolete) from the Great Western Sugar Company. Both cycles of the study were commenced with rigid phenotypic selections for root type, size, and sucrose from both sources which were crossed reciprocally using hypocotyl color for hybrid identification. The female (green) plants were selfed to preserve the maternal genotype. After the progeny tests in each cycle, synthetics were produced from selfed seed of

maternal plants with superior progeny performance. Recoverable sucrose was the principal criterion for progeny evaluation in the first cycle. In the second cycle, progeny evaluations were also made for root yield and sucrose. In making the synthetics in the second cycle, some S_1 lines were included in more than one synthetic, especially in the case of recoverable sucrose and root yield. Some of the synthetics were increased through two generations of open pollination (OP_1 and OP_2). The *per se* performances of these various synthetics are compared in Table 1. However, the most important evaluation should come from the crosses between the A and B synthetics (entries 996, 997, and 998), since the breeding method should accumulate, from source A, genes which combine well with genes in source B, and vice versa.

In Table 1, the performances of the Syn A X Syn B crosses (entries 996, 997, and 998) indicate that two cycles of reciprocal recurrent selection have failed to isolate genotypes from sources A and B, which, when combined together, produce plants superior to the better of the two sources (entries 1014 and 1017). On the other hand, the performances of the synthetics *per se* indicate that the method was effective in improving the root yield of the poorer source (A) when the emphasis was on root yield, but not of the better source (B) (see entries 1003, 1010, and 1015). Simultaneously, sucrose and purity of the better sucrose and purity source population (A) were sacrificed (see entries 1000, 1006, and 1009).

When the greatest selection pressure was on sucrose, the Syn B X Syn A hybrid (entry 998) was no better than the better sucrose parent (A) (see entry 1017), but root yield and recoverable sucrose were none-the-less sacrificed (see entry 998 at 11.6 and 1.74 kg/plot, respectively). The *per se* performance of the synthetics showed an improvement of the low sucrose source population (B) (see entries 1012 and 1016) but not of the high sucrose source A population.

Under selection for recoverable sucrose there was no improvement in the Syn B X Syn A hybrid (entry 997) and only one synthetic with improved *per se* performance (entry 1005).

The source populations were significantly different for each character, source A had high sucrose and purity whereas source B had high root yield and recoverable sucrose. The breeding method appears to have succeeded or failed in the following ways.

1. Succeeded in isolating genotypes with primarily additive effects for higher yield in the low yield source population (A), and for higher sucrose in the low sucrose source (B).

2. Failed to isolate genes with additive effects in the high yield and high sucrose sources.

3. Failed to isolate genes with non-additive effects for high yield and high sucrose.

In general, the method would have to be considered a failure. It has accomplished no more than might be expected from recurrent selection or possibly even from mass selection alone. It has probably failed because of insufficient precision to detect genes with small additive effects and genes with large additive effects but present in a very low frequency. Also, it has failed because of the inability to detect genes with nonadditive interaction

Table 1. Root yield, sucrose, thin juice purity, and recoverable sucrose of populations from reciprocal recurrent selection studies.

Entry	Population	Root wt. kg/plot	Sucrose %	Purity %	Rec.suc. kg/plot
996	2nd Cy Syn A X 2nd Cy Syn B; for root yield	15.5	15.6-	95.0-	2.15
1000	2nd Cy Syn A OP_2; for root yield	15.3+	15.9	95.2-	2.19+
1006	2nd Cy Syn A OP_1; for root yield	16.3+	14.9-	94.3-	2.13+
1009	2nd Cy Syn A; for root yield	14.7+	15.6-	95.2-	2.04+
1003	2nd Cy Syn B OP_2; for root yield	15.2	15.5	95.7	2.14
1010	2nd Cy Syn B OP_1; for root yield	16.9	14.6	94.2	2.21
1015	2nd Cy Syn B; for root yield	14.7	15.5	95.6	2.07
998	2nd Cy Syn B X 2nd Cy Syn A; for sucrose	11.6-	16.6	95.8	1.74-
1001	2nd Cy Syn A OP_2; for sucrose	12.9+	16.2	95.9	1.92+
1007	2nd Cy Syn A OP_1; for sucrose	11.8	16.3	96.3	1.77
1002	2nd Cy Syn B OP_2; for sucrose	13.9	15.7	95.5	1.98
1012	2nd Cy Syn B OP_1; for sucrose	14.5	16.4+	96.1+	2.16
1011	2nd Cy Syn A; for sucrose	12.3	16.2	96.2	1.83
1016	2nd Cy Syn B; for sucrose	13.1-	16.2+	95.5	1.91
997	2nd Cy Syn B X 2nd Cy Syn A; for recoverable sucrose	14.3	15.6-	95.7	2.02
999	2nd Cy Syn A OP_2; for recoverable sucrose	12.8+	15.8	96.1	1.83
1005	2nd Cy Syn A OP_1; for recov. sucrose	13.3+	16.4	96.5	2.01+
1002	2nd Cy Syn B OP_2; for recov. sucrose	13.9	15.7	95.5	1.98
1008	2nd Cy Syn B OP_1; for recov. sucrose	14.7	15.6	95.3	2.06
1020	2nd Cy Syn B; for recov.suc.	13.6-	16.4+	96.0+	2.04
1013	1st Cy Syn B OP_1	15.0	16.3+	95.4	2.21
1021	1st Cy Syn B	14.1	15.4	95.0	1.96
1027	1st Cy Polycross composite of superior A X B crosses	14.5	15.5-	95.5	2.02
1017	Source A	10.8	16.5	96.6	1.64
1014	Source B	15.3	15.2	94.8	2.08
LSD (.05)		1.6	0.7	1.2	0.23

+ or - indicates mean is significantly higher or lower than the source population or the higher source (in the case of crosses).

effects (effects probably small and relatively infrequent). These deficiencies may have been due to the inability to achieve 100% hybridization in the A X B and B X A test crosses. In this study the test crosses were about 75% hybrids and 25% sibs, based on a separate experiment to establish the frequency of hybridization. Unless the combining ability of source A with B was quite dramatic, the masking effect of 25% sibs in the test hybrids would probably prevent the identification of relatively small or infrequent additive and nonadditive effects in the test crosses.

Other adaptations can be devised that would insure 100% hybridization in the test crosses of reciprocal recurrent selection in sugarbeet but it would require the use of self fertile source populations that also were segregating for Mendelian male sterility. The limitations that this would impose on choice of source populations would probably restrict use of the breeding method to academic studies. Hence, it would appear that reciprocal recurrent selection is not likely to be of value to the applied sugarbeet breeder.

Results of Five Cycles of Recurrent Selection for General Combining Ability.--R. J. Hecker.

A small recurrent selection program in sugarbeet has been carried through five cycles. The performance of the synthetic populations from each cycle is reported here.

In fact, the study was a combination of mass and recurrent selection for general combining ability. The original population, GW 359, was an open-pollinated multigerm variety (now obsolete), adapted in northern Colorado. Each cycle was commenced with phenotypic selections which were greater than one standard deviation above the mean of the population for root weight and sucrose content (sometimes over two standard deviations, depending on numbers of individuals available). These phenotypic selections were interpollinated and the open pollinated progenies from each selection were then compared in a field test. First cycle maternal plants were asexually propagated and the first cycle synthetic was generated from asexual plants which had superior progeny. The 2nd, 3rd, and 4th cycle synthetics were generated from a composite of the open-pollinated seed from maternal plants with superior progeny. The 5th cycles synthetic was from S_1 seed of superior maternal plants. Sixty to 100 progeny lines were evaluated each cycle except cycles 1 and 2 in which there were only 27 and 30 progenies, respectively. Each synthetic was used immediately for the next cycle without a generation of interpollination.

The synthetics from the five cycles are listed in Table 1 along with the source population. The selection method resulted in a loss of root yield, significant in the 3rd, 4th, and 5th cycles. There was also a significant loss in recoverable sucrose in the 4th and 5th cycles. Sucrose and purity were unchanged, except the 3rd cycle which had an inexplicably higher sucrose. Hence, the breeding methods used were not successful in isolating and increasing the frequency of genes with superior additive effects and/or interactions.

Recurrent selection as used in this study should sort out and increase the frequency of genes which combine well with other genes within the population, and should increase the frequency of genes with large additive effects.

The method has failed miserably. Among the more plausible explanations are (1) there was no segregation for genes with large additive effects; this was possible; (2) too few individuals were progeny tested to pick up higher combining genotypes; this was possible; (3) there were few or no segregating genes that interacted well with other genes in the population; this was not likely since earlier studies on the variety GW 359 showed that superior genetic deviates did occur in the population, and that those individuals were likely superior because they were a recombination of genes which interacted favorably; (4) significant self pollination was occurring; this was not likely; and (5) unequal contribution of parents to synthetics; this was possible.

Results such as these are disheartening for breeders. It is because breeding methods are not as effective as they theoretically should be that new methods are needed in sugarbeets and other crops to identify and isolate superior combining genotypes. Such new methods, in my opinion, are likely to utilize physiological or biochemical measurements or assessments, especially for root yield, along with combining ability tests, and recombination of promising types.

Table 1. Root yield, sucrose, purity, and recoverable sucrose of populations from recurrent selection studies.

Entry	Population	Root wt. kg/plot	Sucrose %	Purity %	Recov.suc. kg/plot
1023	1st Cy Syn from asex. plants	15.7	15.9	95.2	2.23
1025	2nd Cy Syn	13.9	15.8	95.1	1.96
1024	3rd Cy Syn	13.2-	16.3+	95.1	1.94
1026	4th Cy Syn	11.3-	15.9	95.3	1.60-
1018	5th Cy Syn	12.5-	15.6	94.6	1.72-
1014	GW 359 (source)	15.3	15.2	94.8	2.08
LSD (.05)		1.6	0.7	1.2	0.23

+ or - indicates mean is significantly greater or less than the source population.

Breeders Seed Quality and Stand.--G. A. Smith.

One of the consistent and perennial problems in sugarbeet breeding programs is the limited quantities of seed from crosses involving limited numbers of plants. This problem is often accentuated by incomplete pollination and/or other environmental factors which cause seed quality to be reduced. In our breeding program, this problem has necessitated over-planting of seed to insure complete stands within our experimental plots. Frequently, this overplanting results in very thick stands which then require additional time and expense thinning. Experience has shown that 1.5-2 grams of seed for a 20-22 foot row is dispensed well by our cone planter.

With recent acquisition of an "Oliver" air-gravity seed processing table, we can now process small quantities of seed (as low as 150 grams). Use of this machine enables separation of a seed lot into many sublots, each of which may differ morphologically and/or physiologically. We have found that separation into 3 seed lots (A, B, and C lots) gives the best separation for the wide disparity of seed lots in our program. We usually retain the A and B lots and discard the C lot. Even very poor seed lots are improved drastically by one pass over the table. "A" seed lots most frequently give 80-100% crack tests after one pass over the table.

The experiment reported here was designed to determine how much seed of differing crack tests would be required to establish adequate stands in our 20 foot plots with a minimum of hand thinning. The objective was not to plant to stand.

Table 1. The number of plants per foot as influenced by quality and amount of seed.

Genotype	Crack[1] Test %	Seed[2] mixture gms.	Plants/ft
1 "A" lot	100	2 1 + 0 h	5.50
1 A	100	1 1 + 1 h	2.66
1 A	100	.5 1 + 1 h	1.71
1 B	40	2 1 + 0 h	2.48
1 B	40	1 1 + 1 h	1.26
1 B	40	.5 1 + 1.5 h	0.82
2 A	84	2 1 + 0 h	4.02
2 A	84	1 1 + 1 h	2.52
2 A	84	.5 1 + 1.5 h	1.13
2 B	36	2 1 + 0 h	2.05
2 B	36	1 1 + 1 h	1.22
2 B	36	.5 1 + 1.5 h	0.81
3 A	80	2 1 + 0 h	2.78
3 A	80	1 1 + 1 h	1.55
3 A	80	.5 1 + 1.5 h	0.78
3 B	20	2 1 + 0 h	0.78
3 B	20	1 1 + 1 h	0.49
3 B	20	.5 1 + 1.5 h	0.28
4 A	80	2 1 + 0 h	4.73
4 A	80	1 1 + 1 h	2.90
4 A	80	.5 1 + 1.5 h	1.78
4 B	64	2 1 + 0 h	4.23
4 B	64	1 1 + 1 h	2.23
4 B	64	.5 1 + 1.5 h	1.53

[1]Crack test % is based on a random sample of 100 seeds.

[2]Seed mixtures were 2 grams live (1) seed, 1 gram live (1) seed, .5 grams live (1) seed plus 0 grams heat killed (h) seed, 1 gram heat killed (h) seed, or 1.5 grams heat killed (h) seed.

In this study, seed lots of four breeding lines with differing initial crack tests were processed over the gravity table and the "A" and "B" seed lots crack tested. Each of these seed lots were then planted 3 ways: 2 grams of seed alone, 1 gram of seed plus 1 gram of heat killed seed, and one-half gram of seed plus 1½ grams of heat killed seed. The experimental design was a randomized block with 12 replications. Stand counts, as number of plants per foot, were taken May 19, 1976 (30 days after planting).

A summary of the results are presented in Table 1 above. One gram of live seed plus 1 gram of heat killed seed, gave adequate stands (1.5-2.9 plants per foot) for seed lots which crack tested 64% or greater.

These same seed lots with a 64% or greater crack test gave more than adequate stands with 2 grams of live seed alone (2.7-5.5 plants per foot). These same lots generally gave inadequate stands when only .5 gram live seed were planted with 1½ grams of heat killed seed. The major deficiency with this planting rate was non-uniform within row spacing. "B" seed lots of genotypes 1 and 2 which had low crack tests gave adequate stands and fair distribution as long as 2 grams of live seed were planted.

Although several exceptions were noted, we have concluded that seed lots with crack tests of 80% or greater will give adequate prethinning stands with 1 gram of well distributed seed per 22 foot of row.

Experimental Hybrids Involving Rhizoctonia Resistant Pollinators.--R. J. Hecker and G. A. Smith.

As new or advanced rhizoctonia resistant lines are developed in our program of breeding for resistance, we have combined them with a series of experimental and commercial male sterile lines. These experimental hybrids are used in an assessment of the combining ability of the resistant pollinators. In 1976, we evaluated 97 such hybrids. Table 1 lists the most superior among these hybrids, evaluated under disease free conditions in a 10 X 10 triple lattice (6 reps) at Fort Collins.

None of the experimental hybrids were significantly better than the check. However, several of the hybrids merit further testing for potential use in production areas where rhizoctonia root rot may be a problem.

The general combining ability rank of the pollinators (best to worst) was as follows: FC 703 (4n), (FC 702/5 X FC 701/5, F_2), FC 701/4 (4n), FC 703, FC 703-GH Sel., FC 702/5, FC 702/4 (4n), FC 701/5, FC 702/4, and FC 801.

Table 1. Superior experimental hybrids in the 1976 test of hybrids involving rhizoctonia resistant pollinators.

Entry no.	Hybrid	Recov. sucrose (T/A)	Root yield (T/A)	Sucrose (%)	T. J. purity (%)
870	(562 CMS X 546) X FC 703	3.43	25.0	15.5-[1]	94.4
857	FC 506 CMS X FC 703 (4n)	3.39	22.4	16.9	95.0
852	[(FC 504 CMS X FC 502/2) X 662119s1] X FC 703-GH Sel.	3.34	21.9	16.9	95.3
881	(100363 X 12166) X FC 703 (4n)	3.33	23.6	15.8	94.8
867	FC 602 CMS X FC 703 (4n)	3.33	22.8	16.4	94.8
876	GW 918 X FC 703 (4n)	3.31	22.8	16.3	94.7
899	9399 X FC 703 (4n)	3.31	24.0	16.0	93.6
869	[(FC 504 CMS X FC 502/2) X 662119s1] X FC 701/5	3.30	24.1	15.8	93.7
896	H65-02-69 X FC 703 (4n)	3.30	23.6	15.9	94.4
875	9399 X FC 701/4 (4n)	3.22	23.6	15.8	93.3-
911	(562 CMS X 569) X FC 703	3.20	21.9	16.3	94.7
846	E 929 X FC 701/4 (4n)	3.18	22.9	15.9	94.0
895	[(FC 504 CMS X FC 502/2) X 662119s1] X FC 702/5	3.18	20.8	16.8	95.6
864	[(FC 504 CMS X FC 502/2) X 662119s1] X 703	3.17	22.5	15.9	94.9
898	H65-02-69 X FC 703	3.17	21.3	16.6	95.1
Check	Mono Hy D2	3.35	22.9	16.5	94.7

[1] - indicates a mean significantly smaller than the check.

Taproot Growth Partitioning Ratio and Seedling Hypocotyl Diameter in Sugarbeets.-- M. S. Crawford[1] and G. A. Smith.

The ability to estimate the yield potential of a sugarbeet variety while still in the seedling stage would simplify and hasten the variety testing process. Varieties could be tested year around in growth chambers or greenhouses, testing a new group of varieties every three to four weeks. Such a test could be used in the screening of experimental hybrids. It would enable a large number of varieties to be grouped into broad categories according to yield potential. The plants with the lowest yield potentials could be eliminated from future yield trials.

Two proposed early yield measuring techniques are taproot growth partitioning ratio (TGPR = $\frac{\text{hypocotyl + taproot fresh weight}}{\text{leaf blade + petiole fresh weight}}$) (1) and seedling hypocotyl diameter (2). Both of these methods are being used as selection and screening tests to either improve breeding strains or to create new varieties. The TGPR is an attempt at identifying plants with greater translocation of photosynthate to the taproot. The TGPR quantifies the relationship of the taproot to the photosynthetic capacity of the plant. A plant with a greater leaf area accretion and greater translocation to the taproot should out-yield one with less of either characteristic (1). Care must be used in interpreting TGPR results because even a small, low yielding, high sugar variety may show a high TGPR merely by having a favorable taproot to leaf ratio. The seedling hypocotyl diameter is thought to be a measure of the ability of a plant to expand in root diameter (2,4).

The objective of this experiment was to test the value of both seedling hypocotyl diameter and TGPR in predicting the yield (root weight) potential of sugarbeet varieties.

PROCEDURE

Four inbred lines and the six F_1 hybrids resulting from crossing the four inbreds in all combinations (no reciprocals) were used in this greenhouse experiment. The entries tested were planted in 6 inch diameter (1 gallon) plastic pots. The pots were filled with vermiculite. Forty pots of each entry were completely randomized within the greenhouse. The plants were given 100 ml of nutrient solution (3) every other day. Ten days after the original planting all pots showing no emergence were replanted with the appropriate entry. The individual plants were harvested when they had between six and eight true leaves, each leaf larger than 0.5 cm^2. The hypocotyl diameter was measured 1 cm down from the shoot apical meristem. The weights for the TGPR were obtained by removing the petioles from the hypocotyl, weighing the petiole + leaf blade, then after removing the root hairs from the taproot, weighing the taproot + hypocotyl. Data from three field trials with the same F_1 hybrid entries was used as a measure of actual yield (root weight) potential.

The greenhouse air temperature daytime average high was 33°C, the night time average low was 15°C. The extremes were 40°C and 13°C. The experiment was carried out during July and August (average day length of 14 hours).

[1]Senior undergraduate student, Colorado State University. Research report from special problem course.

RESULTS AND DISCUSSION

The average hypocotyl diameter of the inbreds was 0.134 inches. The range of hypocotyl diameters for the inbred lines was 0.047 inches. The average hypocotyl diameter of the F_1 hybrid lines was 0.144 inches. The range of hypocotyl diameters for the F_1 hybrid lines was 0.023 inches (Table 1). When the entries are ranked by hypocotyl diameter, the inbred lines are nearly equally interspersed with the F_1 hybrid lines. The high ranking of some inbred lines does not support the theory that the seedling hypocotyl diameter is a measure of the ability of the plant to expand in root diameter (2,4), because at maturity the hybrids are expected to have larger taproots than the inbreds.

Table 1. Results from field tests, hypocotyl diameter measurements, and TGPR for the lines tested. Note: The order in which the parents of the hybrids are listed does not denote male or female.

Entry	1969 Field test	1970 Field test high nitrogen	1970 Field test low nitrogen	Hypocotyl diameter	TGPR
	(tons/acre)	(tons/acre)	(tons/acre)	(inches)	
52-307	-----	-----	-----	0.151	0.175
52-305	-----	-----	-----	0.142	0.093
52-407	-----	-----	-----	0.138	0.139
54-346	-----	-----	-----	0.104	0.061
52-305 X 52-407	20.24	17.42	13.75	0.148	0.100
54-346 X 52-407	15.03	15.23	10.52	0.141	0.089
52-307 X 54-346	19.89	13.93	11.10	0.137	0.117
52-305 X 54-346	16.10	13.73	10.15	0.135	0.070
52-305 X 52-307	18.73	15.23	12.93	0.158	0.102
52-307 X 52-407	17.58	15.59	13.78	0.144	0.153

The average TGPR of the inbred lines was 0.177. The range of TGPR for the inbred lines was 0.113. The average TGPR of the F_1 hybrid lines was 0.105. The range of TGPR for the F_1 hybrid lines was 0.084 (Table 1). When the entries are ranked by TGPR, once again, the inbred lines are nearly equally interspersed with the F_1 hybrid lines. Some inbreds are expected to have high TGPR merely because of a favorable root to shoot ratio, even though they remain smaller than the F_1 hybrids.

The field tests from the two different years did not correlate well with each other (Table 2). This is the inherent difficulty in trying to establish the validity of either the seedling hypocotyl diameter or the TGPR. The field tests are subject to large amounts of environmental error and few lines are tested as a group over enough years to accurately characterize their yield potentials. The results of the 1970 low nitrogen field test had the best correlations with both the seedling hypocotyl diameter ($r = 0.71$) and the TGPR ($r = 0.66$) (Table 2).

There was a high correlation between the midparent and the F_1 hybrid for both TGPR ($r = 0.92$) and the seedling hypocotyl diameter ($r = 0.88$). These high correlations suggest the possibility of predicting the TGPR or seedling

hypocotyl diameter of F_1 hybrids from measurements taken on inbred lines. This high correlation with the midparents suggests that both traits are controlled by additive gene action.

Table 2. Correlation coefficients among the results of the three field tests, the hypocotyl diameter, and the TGPR.

	TGPR	Hypocotyl diameter (inches)	1970 Low nitrogen field test (tons/acre)	1970 High nitrogen field test (tons/acre)
1969 Field test (tons/acre)	0.35	0.38	0.59	0.37
1970 Field test high nitrogen (tons/acre)	0.24	0.55	0.77	
1970 Field test low nitrogen (tons/acre)	0.66	0.71		
Hypocotyl diameter (inches)	0.20			

In most cases all seedling characteristics measured in this experiment correlated highly with each other (Table 3). This implies that measurement of the hypocotyl diameter is no better measure of growth rate than the measure of any other seedling organ growth rate.

Table 3. Correlation coefficients among seedling characteristics.

Entries	Corr. coefficient between leafblade plus petiole weight and hypocotyl diam.	Corr. coefficient between hypocotyl plus taproot weight and leafblade plus petiole weight	Corr. coefficient between hypocotyl diameter and hypocotyl plus taproot weight
52-305 X 52-407	0.90	0.92	0.91
54-346 X 52-407	0.93	0.94	0.92
52-307 X 54-346	0.92	0.92	0.93
52-305 X 54-346	0.93	0.85	0.88
52-305 X 52-307	0.63	0.87	0.79
52-307 X 52-407	0.91	0.92	0.92
52-407	0.85	0.87	0.92
52-305	0.84	0.81	0.89
54-346	0.89	0.90	0.90
52-307	0.93	0.93	0.89

CONCLUSIONS

From this experiment the utility of either seedling hypocotyl diameter or TGPR, as early yield (root weight) screening tests, cannot be determined. Ideally, the field yield tests should have correlated with each other a great deal better. Many more experiments combining measurement of seedling hypocotyl diameter and TGPR with comparisons to field trial data will be necessary to either prove or disprove the validity of these theories.

The seedling hypocotyl diameter does not appear to be a measure of the ability of a plant to expand in root diameter. The seedling hypocotyl diameter appears to be a measure of growth rate, and is no better than the measure of growth rate using any other organ of the plant.

The high correlation between the midparent and F_1 hybrid for both TGPR and hypocotyl diameter was unexpected. If either or both of these measurements prove useful this high correlation will enable prediction of F_1 hybrid characteristics from measurements taken on the inbred parents.

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<u>Regional Coop Test of LSR-CTR Experimental Lines</u>.--G. A. Smith, R. J. Hecker, S. S. Martin, and E. G. Ruppel.

Seven crosses from our disease resistance breeding programs were evaluated at Fort Collins, Willcox, Arizona, Worland, Wyoming, Bird Island, Minnesota, and Ulysses, Kansas. Cooperation of research personnel of American Crystal, Spreckels, and Holly sugar companies made these regional tests possible. The primary objective of this year's test was to evaluate the combining ability for leaf spot and curly top of several leaf spot-curly top resistant lines, under widely diverse environments. Single or 3-way crosses of these lines were produced using the multigerm LSR-CTR or LSR-rhizoctonia resistant pollinators FC 902, 701/5, 702/5, or 703 and the LSR monogerm line FC 506 (Table 1). The inbred lines 642027, 662119, and 652016 have shown good disease resistance and yield potential in several 3-way monogerm crosses recently developed and evaluated at Fort Collins.

Under severe leaf spot at Fort Collins (Table 2), entries 4, 5, and 7 performed the best for recoverable sugar as compared to the checks. The

fact that Mono Hy D2 did so well under leaf spot is obviously not because it is LSR, but because of time of leaf spot development. This variety characteristically develops leaf spot symptoms very late in the growing season and hence, escapes severe effects on yield. Under Fort Collins disease-free conditions, entries 1, 5, and 6 gave the highest relative recoverable sugar (Table 3). Entries 4, 5, and 7 performed well under nondisease conditions at Worland, Wyoming (Table 4). At Willcox, Arizona, entries 2 and 7, both of which have the same CMS single cross parent, performed relatively well (Table 5). The superior curly top resistance of this CMS single cross obviously was a factor here. Entries 4 thru 7 performed well at Bird Island, Minnesota. These four entries had the FC 700 series as their pollinators (Table 6). All entries except entry 3 performed somewhat better than the check at Ulysses, Kansas. As can be seen in Table 7, tonnages were high and sucrose was low at this location. Entries 1, 2, and 7 gave the highest recoverable sugars. All three of these entries are 3-way crosses with 662119s1 as a common female parent.

With only a limited number of pollinators used, it is impossible to get much information on combining ability. However, this information is valuable when used with other accumulated information especially because of the diversity of locations involved.

Table 1. Description of material in cooperative evaluation tests of LSR-CTR varieties, 1976.

Entry no.	Seed no.	Entry description
1	751104H3	(642027s1 CMS X 662119s1, TO) CMS, high resistance to CT infection, mm X FC 902, LSR-CTR MM
2	751104H2	(652016s1 CMS X 662119s1, TO) CMS, high resistance to CT infection, mm X FC 902, LSR-CTR, MM
3	751105H02	(652016s1 CMS X 662119s1, TO) CMS, high resistance to CT infection, mm X FC 506, TO, LSR, mm
4	741038H3	662119s1 CMS X (FC 702/5 X FC 701/5, F_2)
5	741039H3	662119s1 CMS X FC 701/5
6	741046H4	(562 CMS X 569) X FC 703
7	741040H5	(652016s1 CMS X 662119s1) X FC 702/5
8	A75-2	GW Mono Hy D2, check
9	731083	Synthetic check, LSS check
10	671201H08	FC(504 X 502/2) X SP 6322-0, LSR check

Table 2. Cooperative Agronomic Test of LSR-CTR Varieties, 1976

Location: Fort Collins, CO (3A), under severe leaf spot

Seed no. or variety	Entry no.	Plot yield: Root weight kg	Root weight % check	Sucrose %	Sucrose % check	Purity %	Purity % check	Recoverable sugar kg	Recoverable sugar % check	Leaf spot[1]
751104H3	1	31.963	90	15.42	94	94.43	100	4.36	84	4.0
751104H2	2	32.356	91	15.68	95	94.88	101	4.53	88	3.4
751105HO2	3	30.394	86	16.59	101	94.23	100	4.45	86	3.4
741038H3	4	32.531	92	16.61	101	94.08	100	4.76	92	4.1
741039H3	5	33.694	95	15.81	96	93.50	99	4.62	89	4.1
741046H4	6	28.781	81	15.67	95	92.98	99	3.87	75	5.0
741040H5	7	31.638	89	16.74	102	94.80	100	4.74	92	3.4
A75-2(check)	8	35.519	100	16.43	100	94.33	100	5.17	100	5.0
731083 LSS check	9	24.500	69	15.18	92	92.15	98	3.13	61	6.9
671201HO8 LSR check	10	33.831	95	16.57	101	94.05	100	4.93	95	3.0
General Mean		31.520		16.068		93.94		4.452		4.23
CV %		8.5		2.06		1.0		9.0		10.3
LSD (.05)		3.22	9	0.40	2	0.58		0.48	9	0.52

[1]Basis of leaf spot grades: 0-10 scale; 0 = no infection, 10 = defoliation.

Conducted by: G. A. Smith and E. G. Ruppel.

Dates of Planting and Harvest: April 21 and October 4, 1976.

Experimental Design (Including No. of Reps): Randomized block design with 4 replications of two row plots. Plot length 20 feet.

Determination of Beet Yield and Sucrose Percentage: Standard methods.

Leaf Spot Exposure: Severe, artificially induced.

Curly Top Exposure: None.

Other Diseases and Pests: None.

Reliability of Test and Remarks: Very satisfactory.

Table 3. Cooperative Agronomic Test of LSR-CTR Varieties, 1976
Location: Fort Collins, CO (Exp. 1) disease free.

Seed no. or variety	Entry no.	Plot yield: Root weight kg	Root weight % check	Sucrose %	Sucrose % check	Purity %	Purity % check	Recoverable sugar kg	Recoverable sugar % check
751104H3	1	31.69	95	13.91	95	93.26	101	3.79	91
751104H2	2	29.59	88	13.53	92	93.72	101	3.46	83
751105H02	3	24.98	75	14.71	100	94.06	102	3.25	78
741038H3	4	28.25	84	14.50	99	92.74	100	3.49	83
741039H3	5	30.74	92	14.30	97	92.20	100	3.72	89
741046H4	6	29.15	87	14.98	102	92.74	100	3.72	89
741040H5	7	26.62	80	14.66	100	93.68	101	3.39	81
A75-2(check)	8	33.48	100	14.68	100	92.44	100	4.18	100
General Mean		29.31		14.41		93.11		3.62	
CV %		11.75		3.18		0.74		12.66	
LSD (.05)		3.71	11	0.49	3	0.75		0.49	12

Conducted By: G. A. Smith.

Dates of Planting and Harvest: April 20 and October 5, 1976.

Experimental Design (Including No. of Reps): Randomized block design with 5 replications of 2 row plots. Plot length 20 feet.

Determination of Beet Yield and Sucrose Percentage: Standard methods.

Leaf Spot Exposure: None.

Curly Top Exposure: None.

Other Diseases and Pests: Some nematode present.

Reliability of Test and Remarks: Satisfactory.

Table 4. Cooperative Agronomic Test of LSR-CTR Varieties, 1976
Location: Worland, Wyoming

Seed no. or variety	Entry no.	Acre yield: Gross sucrose lbs	Gross sucrose % check	Beets tons	Beets % check	Sucrose %	Sucrose % check	Beets/ 100'
751104H3	1	7929	97	24.2	102	16.41	95	107
751104H2	2	6825	83	20.6	87	16.55	96	99
751105H02	3	7577	93	21.7	92	17.46	101	111
741038H3	4	8966	110	25.9	110	17.30	100	109
741039H3	5	8768	107	25.0	106	17.53	101	103
741046H4	6	7302	89	21.7	92	16.85	97	98
741040H5	7	8584	105	24.6	104	17.46	101	108
HH25		9428	115	27.4	116	17.21	100	111
HH21 (check)		8183	100	23.6	100	17.29	100	112
General Mean		8173		23.8		17.12		106
CV %		11		9.7		3.26		
Calculated F		8.03**		8.18**		4.94**		

Conducted By: Holly Sugar Corporation.

Dates of Planting and Harvest: April 11 and October 7, 1976.

Experimental Design (Including No. of Reps): Randomized complete block design with 9 replications of one row plots. Plot length 22 feet.

Determination of Beet Yield and Sucrose Percentage: Standard methods.

Leaf Spot Exposure: None.

Curly Top Exposure: None.

Other Diseases and Pests: None.

Reliability of Test and Remarks: Satisfactory.

Table 5. Cooperative Agronomic Test of LSR-CTR Varieties, 1976
Location: Willcox, Arizona[1]

Seed no. or variety	Entry no.	Plot yield: Beets tons	Beets % check	Sucrose %	Sucrose % check	Recoverable sugar tons	Recoverable sugar % check	Curly top %	Beets/100' no.
751104H3	1	22.24	89	15.41	97	3.432	87	17	102
751104H2	2	22.83	92	15.78	100	3.604	92	18	83
751105H02	3	20.01	80	16.15	102	3.238	82	26	92
741038H3	4	18.75	75	15.53	98	2.932	75	27	62
741039H3	5	19.72	79	15.33	97	3.017	77	43	102
741046H4	6	16.61	67	15.23	96	2.530	64	43	68
741040H5	7	22.53	91	16.28	103	3.668	93	19	76
Mono Hy D2, ck		24.86	100	15.81	100	3.931	100	43	108
H 75582		24.84	100	16.44	104	4.081	104	32	108
Blend[2]		23.56	95	15.60	99	3.686	94	31	113
S-239H		22.52	91	16.11	102	3.624	92	44	109
USH9B1		23.15	93	15.22	96	3.520	90	26	100
General Mean		21.81		15.74		3.439		31	94
CV %		11.38		3.54		12.22		25.62	12.88
LSD (.05)		2.47	10	0.55	3	0.418	11	8	12

[1]Data from average of Thimet and non-Thimet treated plots.

[2]Blend is a 50:50 mixture of USH9B1 and Mono Hy D2.

Conducted By: Spreckels Sugar Company.

Dates of Planting and Harvest: March 25 and November 23, 1976.

Experimental Design (Including No. of Reps): Randomized complete block design with 8 replications. Plot size 2 rows X 40 feet.

Determination of Beet Yield and Sucrose Percentage: Standard methods.

Leaf Spot Exposure: Light, controlled by 3 sprayings with Duter.

Curly Top Exposure: Moderate with infection occurring late.

Powdery Mildew: Traces only, controlled by 3 sprayings of Thiolux mixed with the Duter.

Reliability of Test and Remarks: Satisfactory.

Table 6. Cooperative Agronomic Test of LSR-CTR Varieties, 1976

Location: Bird Island, Minnesota

Seed no. or variety	Entry no.	Acre yield: Beets tons	Beets % check	Gross sugar lbs	Gross sugar % check	Rec. sugar lbs	Rec. sugar % check	Sucrose %	Sucrose % check
751104H3	1	13.2	89	4514	89	4067	88	17.0	99
751104H2	2	12.7	86	4314	85	3924	85	16.9	98
751105H02	3	10.4	70	3695	73	3372	73	17.8	103
741038H3	4	14.9	101	5008	99	4406	96	16.9	98
741039H3	5	13.9	94	4749	93	4157	90	17.1	99
741046H4	6	15.3	103	5303	104	4769	103	17.3	101
741040H5	7	14.2	96	4893	96	4449	96	17.3	101
ACS check		14.8	100	5079	100	4611	100	17.2	100
General Mean		13.7		4695		4219		17.2	
CV %		12.2		12.4		12.6		2.3	
HSD (.05)		2.7	18	925	18	844	18	0.6	3

Conducted By: American Crystal Sugar Company.

Experimental Design: Latin Square 8 X 8.

Determination of Plot Yield and Sucrose Percentage: Standard methods.

Reliability of Test: Satisfactory.

Table 7. Cooperative Agronomic Test of LSR-CTR Varieties, 1976

Location: Ulysses, Kansas

Seed no. or variety	Entry no.	Acre yield: Root weight tons	Root weight % check	Sugar lbs	Sugar % check	Rec. sugar lbs	Rec. sugar % check	Sucrose %	Sucrose % check
751104H3	1	42.1	118	8810	116	6997	114	10.5	99
751104H2	2	39.4	110	8663	114	7050	115	10.9	103
751105H02	3	32.5	91	7420	97	6006	98	11.4	108
741038H3	4	38.2	107	8563	112	6755	110	11.3	107
741039H3	5	39.5	110	8502	112	6548	106	10.7	101
741046H4	6	36.1	101	8222	108	6591	107	11.4	108
741040H5	7	36.9	103	8556	112	7033	114	11.6	109
ACH 17, check		35.8	100	7612	100	6150	100	10.6	100
General Mean		37.6		8294		6641		11.1	
CV %		6.4		7.7		8.4		3.9	
HSD (.05)		3.8	11	1012	13	887	14	0.7	7

Conducted By: American Crystal Sugar Company.

Experimental Design: Latin Square 8 X 8.

Determination of Plot Yield and Sucrose Percentage: Standard methods.

Reliability of Test: Satisfactory.

CERCOSPORA LEAF SPOT RESEARCH, 1976

The Quantitative Effect of Cercospora Leaf Spot on Sugarbeet Yield and Nonsucrose Components, 1976.--G. A. Smith and S. S. Martin.

As reported in the 1975 Sugarbeet Research reports (see pages C17 thru C20), we have designed a field experiment in which *Cercospora*-infected and relatively uninfected genotypes can be grown under identical environments (*i.e.*, the same year at the same time in the same experiment). The report presented here is a summary of 2 years data taken on eight genotypes with differing levels of leaf spot resistance. Data were obtained for root yield, sucrose, purity, gross sucrose, and for the nonsucrose chemical components sodium, potassium, betaine, nitrate, amino nitrogen, total nitrogen, and chloride.

Table 1 summarizes the data for all characters except betaine, potassium, and chloride, which did not exhibit any discernable effects due to cercospora infection in either of the two years. As seen in Table 1, genotypes which have about the same inherent *Cercospora* resistance do not respond identically to infection. In general, high levels of infection resulted in increased concentrations of nonsucrose chemical components and in reductions in root weight, sucrose %, purity %, and gross sucrose.

Genotype X year interactions were numerous (Table 1). Many of these, however, were caused by only slight changes in rank between the two years. Genotype 1817, which was the most resistant entry in the experiment, showed reductions in sodium, nitrate, amino N, and total N in 1975, but showed increased amounts in 1976. Of the seven nonsucrose chemical characters measured, sodium, nitrate N, and amino N showed the highest association with degree of leaf spot infection in both years. Nitrate N showed the widest range of response to infection and also the highest percentage increase with infection. The increased concentrations of these chemical components found with increased leaf spot infection is a logical explanation for the reduction in sucrose and purity seen with increasing leaf spot infection.

Table 1. Percent change in yield and quality components in response to *Cercospora beticola* infection, and the correlation coefficients (r) between degree of infection and percentage change of components.[2]

Genotype	L.S.[1] difference		Sodium	Nitrate	Amino N	Total N	Root wt.	Sucrose %	Purity %	Gross sucrose
					% change in component, 1975					
1817	2.00		- 6.52	-13.53	- 4.26	- 7.14	- 3.58	1.09	0.10	2.64
1824	2.13		-15.90	0.00	12.50	0.00	- 7.64	- 2.15	- 0.18	- 5.68
1818	2.50		26.31	47.48	29.47	30.00	- 3.24	- 3.20	- 0.55	- 6.30
1821	3.25		18.75	- 6.45	38.15	36.36	- 4.86	- 2.12	- 0.68	- 6.85
1823	4.63		29.03	13.09	38.70	27.27	-17.26	- 2.24	- 0.72	-19.00
1820	5.75		75.80	106.28	30.05	25.00	-11.20	- 8.59	- 1.17	-18.90
1822	5.88		56.86	44.31	36.28	50.00	-18.28	- 5.59	- 0.77	-23.20
1819	6.13		35.21	123.07	60.05	7.69	-28.16	-10.84	- 1.58	-36.10
		r =	.84**	.77*	.75*	.45	-.84**	-.84**	-.87**	-.92**
					% change in component, 1976					
1817	2.37		3.03	14.28	10.15	27.27	- 7.61	- 3.48	- 0.34	-10.78
1824	2.38		3.33	-16.66	9.37	- 7.14	-10.47	1.00	- 0.07	-11.46
1818	2.50		51.61	100.00	40.57	16.66	- 4.66	- 4.78	- 1.31	- 9.16
1821	3.12		96.29	26.66	35.29	25.00	-10.77	- 3.80	- 1.13	-13.87
1823	4.50		82.35	75.00	69.45	25.00	-21.66	- 5.29	- 1.02	-25.75
1820	4.75		31.91	107.14	15.16	0.00	-29.04	-11.35	- 1.07	-37.37
1822	4.88		30.30	141.66	56.15	7.14	-29.49	- 8.29	- 1.16	-35.30
1819	5.13		95.74	229.41	63.30	15.38	-32.59	-15.67	- 2.48	-42.60
		r =	.44	.79*	.64	.06	-.97**	-.83**	-.66	-.97**

[1]L.S. difference = the difference in leaf spot reading between benomyl treated and nontreated plots. Plots treated with benomyl had little or no leaf spot.

[2]Percent change = the average % difference between plots sprayed with benomyl (essentially disease-free) and those plots not sprayed. Chemical data were in mg/100 ml raw juice.

*,** significance at the 5% and 1% probability levels, respectively.

Breeding for Leaf Spot and Curly Top Resistance, 1976.--G. A. Smith and E. G. Ruppel.

Table 1 presents the leaf spot and curly top evaluation of some breeding lines from our leaf spot and leaf spot-curly top breeding program. Experience has shown that combining high levels of resistance to both diseases in the same line is very difficult. Entry number 1335 has shown good levels of resistance to both diseases over the last 2 years. This year, under more severe epidemics of leaf spot and curly top, the cross looked very good. Limited data on sucrose and root yield indicate that this cross performs well. We are currently in the process of producing the type O equivalent of this 3-way cross which, along with the CMS, will be a probable Foundation release.

Entry 1337 is a 3-way cross which has shown the highest consistent level of resistance to *Cercospora* we have seen in our leaf spot nurseries. Prior to this cross, FC(504 X 502/2) X SP 6322-0 has been the most leaf spot resistant and is used as our LSR check variety. Because the 3 lines in entry 1337 occur as both CMS and type O, synthesis of a type O and its CMS equivalent of this cross is also possible. The high leaf spot resistance of rhizoctonia-resistant entries 1368 and 1369 also is noteworthy.

Table 1. Mean leaf spot and curly top ratings of some breeding lines tested at Fort Collins and/or Logan, Utah, 1976. Test conducted by G. A. Smith and D. L. Mumford.

Entry no.	Seed no.	Description	Leaf[1] spot	Curly[1] top
1322	751032H02	FC 605 CMS,LSR-CTR,mm X L-35,CTR,T.O.,mm	5.13	3.0
1323	751032H03	(642027s1 CMS X 662119s1,T.O.) X L-35,T.O.	5.75	2.0
1324	751032H04	[652016s1 CMS(B_4),LSR-CTR X 662119s1,T.O.] X L-35,T.O.,mm	5.63	2.0
1325	751032H05	FC 506 CMS,LSR,mm X L-35,CTR,T.O.,mm	5.13	-
1326	751099H	L-19,MM,high sucrose	6.88	7.5
1327	751099H2	FC 506 CMS,mm X L-19,MM,high sucrose	4.13	6.0
1328	751099H3	FC 601/2 CMS,mm X L-19,MM,high sucrose	4.50	6.0
1329	751099H4	FC 605 CMS,mm X L-19,MM,high sucrose	4.25	5.5
1330	751101HO	L-36, CTR, T.O.	6.75	2.5
1331	751101H02	(642027s1 CMS X 662119s1,T.O.,mm) X L-36, CTR,T.O.	4.13	3.0
1332	751101H03	[652016s1 CMS (B_4)LSR-CTR X 662119s1,T.O., mm] X L-36, CTR, T.O.	3.75	3.0
1333	751102HO	FC 605, T.O.,LSR-CTR,mm,S.F.	3.00	4.5
1334	751102H01	FC 605 CMS	3.13	-
1335	751102H02	[652016s1 CMS (B_4) X 662119s1,T.O.,mm] X FC 605, T.O., mm	3.13	3.5
1336	751102H03	(642027s1 CMS X 662119s1 T.O.,mm) X FC 605, T.O.,mm	2.88	4.0
1337	751102H04	F_1, FC(504 X 502/2) CMS,LSR,mm X FC 605,T.O.	2.13	4.0
1338	751102H05	FC 506 CMS X FC 605 T.O.	2.38	5.0
1339	751103HO	731037HO = 652001s1 CMS high CTR X 672003-0 mm (652001s1 CMS X 671003-0) X (642027s1 CMS X 662119s1,T.O.)high CTR	3.13	4.0
1340	751103H02	(642027s1 CMS X 662119s1,T.O.) X 731037HO high CTR	3.25	4.5
1341	751103H03	(652016s1 CMS X 662119s1,T.O.,mm),LSR-CTR X 731037HO high CTR	3.13	4.0
1342	751103H04	FC 605 CMS X 731037HO high CTR	3.25	3.0

Table 1. (Continued)

Entry no.	Seed no.	Description	Leaf spot[1]	Curly top[1]
1343	751104H	FC 902,LSR-CTR, MM	4.13	5.0
1344	751104H2	(652016s1 CMS X 662119s1,T.O.,mm) X FC 902, MM,LSR-CTR	4.00	4.5
1345	751104H3	(642027s1 CMS X 662119s1,T.O.)mm X FC 902, LSR-CTR,MM	3.38	3.5
1346	751104H4	FC 605 CMS X FC 902, LSR-CTR, MM	3.63	4.5
1347	751105H02	[652016s1 CMS (B_4) LSR-CTR X 662119s1,T.O., mm] mm X FC 506,T.O.,LSR,mm	2.75	5.0
1348	751107H0	721055H0, good CA for CT also LSR	4.50	6.5
1349	751109H0	632028s1,T.O.,LSR-CTR,mm from 611101-0	3.38	4.5
1350	751109H02	FC 601/2 CMS X 632028s1,T.O.,LSR-CTR	3.25	5.5
1351	751114	CR-P35989 LSR Accession	3.38	-
1352	751116	SN-4X-22	4.25	-
1353	751117	AJ-4X-22 Selection from AJ variety	4.00	-
1354	751119H	Progeny of inter pollinated LSR selections from B.vulgaris X B.maritima backcrosses	3.88	-
1355	751119H2	MS 63-(5H0 X6)Am.Crystal X progeny of inter pollinated LSR sel. from B.vulgaris X B. maritima backcrosses	4.25	-
1356	751119H3	FC 605 CMS X progeny of inter pollinated LSR sel.from B.vulgaris X B.maritima BC's	3.13	-
1357	751120H0	FC 605	3.13	-
1358	751120H02	F_1, FC(504 X 502/2)CMS,LSR,mm X FC 605	2.50	-
1359	751120H03	(652016s1 = sub of FC 601 T.O. X 642027s1, CMS,LSR-CTR,mm) X FC 605	2.75	-
1360	751121	SP 7322-0,LSR from Coe	3.50	-
1361	751123H	SP 5481-0,4N	3.88	-
1362	751123H2	SP 5481-0,3N	3.75	-
1363	751124H0	662119s1,T.O.,mm,LSR-CTR,high res. to CT infection, from 62563 X 611227-(001)	5.63	-
1364	751124H01	662119s1 CMS (B_4)	3.88	-
1365	751124H02	F_1, FC(504 X 502/2)CMS,LSR,mm X 662119s1, T.O. mm, LSR-CTR,high res. to CT infection	3.13	-
1366	751131	Pool of 3 Russian accessions,A74-40,A74-50, and A74-52. Diploid monogerm	5.13	-
1367	751132	Pool of 14 Russian multigerm accessions, A74-33 thru A74-49	5.63	-
1368	751034	Intercross of synthetic of 3 best progeny lines for Rhizoc.res.from LSR-CTR,mm,T.O. (recurrent parent) X FC 701, B_1, OP_1, 2 cycles Rhizoc. selection	3.00	-
1369	731088H-1 thru 731088H-11 (composite 2 g each for a total of 16 g)	Synthetic of best progeny lines of 1972 Rhizoc.sel. from LSR-CTR,mm,T.O.(recurrent parent) X FC 701, B_1, OP_1, 2 cycles Rhizoc.selection	2.75	6.0
1370	671201H08	LSR check,FC(504 X 502/2) X SP 6322-0	3.00	-
1371	731083	LSS check, Synthetic check	6.00	-
1372	661201H0	ILSR check, SP 6322-0	3.25	-
CTR,CK		US 41	-	5.0
CTR,CK		US 33	-	6.0

[1]Leaf spot and curly top ratings based on 0-10 scale with 0 = no symptoms and 10 = death for curly top or complete defoliation for leaf spot.

Leaf Spot Evaluations of Sugarbeet Lines Submitted by BSDF-Member Companies.--E. G. Ruppel and G. A. Smith.

Separate randomized block designs with two replications were used to evaluate lines from American Crystal, Great Western, Holly, and Spreckels Sugar Companies. A total of 160 lines were tested. Internal checks included leaf spot-resistant cultivar FC(504 X 502/2) X SP 6322-0, a susceptible synthetic check, and cultivar SP 5822-0 having intermediate leaf spot resistance. The nursery was planted April 21 and inoculated on July 6. The epidemic developed uniformly and reached maximum severity in late August to early September. Leaf spot reading on a scale of 0 to 10 were taken on August 25, August 30, and September 3. Mean leaf spot readings for the susceptible check across dates ranged from 5.3 to 7.3, with an overall mean of 6.2. Readings for the resistant check ranged from 2.5 to 3.5, with a mean of 3.1, whereas those for the intermediate check ranged from 3.0 to 4.0, with a mean of 3.5. Results of these tests were tabulated and sent to each respective contributor.

The Occurrence of Root Sprangling Following Treatment with Benomyl, 1976.--G. A. Smith.

Last year we reported an increase in root sprangling in plots which were sprayed with benomyl (see Sugarbeet Research, 1975 Report, pages C20-C21). The experiment was repeated exactly as described in last year's report except that benomyl treatment began on June 29. Benomyl concentrations were again 3.2 grams per 2 gallons of water (8 ounces per acre). Benomyl sprayed plots had 30.49% of all roots sprangled compared to 27.62% for nonsprayed plots. These figures compare with 30% and 24% for sprayed and nonsprayed plots, respectively, in 1975.

Survival of Benomyl-Tolerant Strains of Cercospora beticola in the Field in the Absence of Benomyl.--E. G. Ruppel (in cooperation with A. D. Jenkins and L. M. Burtch, Spreckels Sugar Division, Amstar Corporation).

In the Willcox, AZ, region where benomyl-tolerant strains of *Cercospora beticola* have been found (these reports, 1975), an area was selected and a moratorium established against the use of any benzimidazole fungicides. Instead, triphenyltin hydroxide ('Du-Ter') was used to control leaf spot. Another area was selected where benomyl will continue to be used alone or in combination with protectant fungicides. Lesions in randomly-collected leaf spot-infected leaves from a field in each area were induced to sporulate and single-spore isolations were made. After adequate growth on potato-dextrose agar, the isolates were transferred to PDA containing 5 μg active ingredient (a.i.) benomyl/ml to ascertain their sensitivity to benomyl. Of 149 isolates from a benomyl-treated field, all were benomyl tolerant. Likewise, 196 isolates from two fields treated only with 'Du-Ter' were benomyl tolerant. To determine the relative degree of tolerance to benomyl, 10 randomly-selected isolates from each area were grown on PDA containing 0, 1, 10, 100, and 1,000 μg a.i. benomyl/ml. In this test, 9 isolates from the benomyl-treated area grew on PDA containing 1,000 μg/ml, whereas only 4 isolates from the 'Du-Ter'-treated area grew at this concentration. Continued bioassays of the *Cercospora* strains are planned for a 3-year period.

Bioassays of Cercospora beticola Strains from Hereford, Texas.--E. G. Ruppel (in cooperation with Paul Scott, Holly Sugar Corporation).

Single-spore isolates from seven leaf spot-infected fields near Hereford, TX, were bioassayed on potato-dextrose agar containing 5 μg active ingredient benomyl/ml (5 ppm). Of 172 isolates, only 3(1.7%) were benomyl sensitive and failed to grow. Benomyl, alone or alternated with protectant fungicides, still is being used in the Hereford area. Benomyl-tolerant strains of the fungus were discovered in 1973.

Comparison of Dry Versus Wet Cercospora Inoculum Application.--E. G. Ruppel and G. A. Smith.

A preliminary test was conducted to compare two inoculum application techniques. One method (W) involved our usual "wet" technique in which dry, *Cercospora*-infected leaves were triturated in water, and the resulting screened spore suspension was sprayed on the foliage. The second method (D) involved grinding the dry leaves in a Wiley mill, mixing with talc, and applying the dry inoculum to the foliage (11 liters of ground leaves + 11 kg talc per acre). Pre- and post-inoculation overhead irrigations were done as usual to create and maintain a leaf spot epidemic. The test was conducted in a border area planted with cultivar GW 674-56C. Two replications were used in four-row plots 6.1 meters long and 56 cm apart. Inoculations were made July 6, and leaf spot readings were taken August 25, 30, and September 3. On August 25, an average reading of 3.8 was obtained for method "D", whereas method "W" gave a reading of 3.0. At the final date of evaluation (September 3), however, all plots were rated 4.0.

Growth and Cercosporin Production of Cercospora beticola as a Function of Time.--E. G. Ruppel and S. S. Martin.

Growth on potato-dextrose agar and in potato-dextrose broth, and toxin (cercosporin) production by *Cercospora beticola* isolates C-1 and C-2 was measured at intervals over a 22-day period. Randomized block designs with four replications were used in each of two trials. Results are presented in Tables 1 and 2. Growth and toxin production were essentially linearly proportional for 18 days and then leveled off. Although growth was not significantly different between isolates, isolate C-2 produced significantly more cercosporin than isolate C-1. Cercosporin production on a dry weight basis (Table 3) was greatest between 11 and 15 days, which corresponds to mature lesion development in sugarbeet.

Table 1. Summary Table of Trials I and II; Growth of two *Cercospora beticola* isolates on potato-dextrose agar (PDA) and in potato-dextrose broth (PDB) at 26 C*.

Isolate	Day	PDA Colony diam I	PDA Colony diam II	PDB Dry weight I	PDB Dry weight II
		(mm)	(mm)	(mg)	(mg)
C-1	4	16	14	17	16
	6	25	23	44	59
	8	35	35	132	89
	11	51	51	207	137
	13	62	62	250	236
	15	71	71	286	333
	18	76	80	378	372
	20	79	81	---	439
	22	84	84	---	384
C-2	4	17	14	17	18
	6	26	23	29	36
	8	36	36	104	83
	11	48	47	164	94
	13	54	52	257	196
	15	59	59	232	282
	18	69	69	364	303
	20	75	73	---	297
	22	79	79	---	326

*Means of four replications.

Table 2. Summary Table of Trials I and II; Cercosporin production by two *Cercospora beticola* isolates grown on potato-dextrose agar (PDA) and in potato-dextrose broth (PDB) at 26 C*.

Isolate	Day	Cercosporin production (µg/culture) PDA (cultures) I	PDA (cultures) II	PDB (mycelium) I	PDB (mycelium) II	PDB (medium) I	PDB (medium) II
C-1	4	7	8	5	0	1	0
	6	44	53	29	23	6	0
	8	51	49	164	77	38	11
	11	50	81	119	132	10	19
	13	47	54	212	367	7	39
	15	41	70	132	493	7	19
	18	42	113	178	257	2	15
	20	--	117	---	427	--	12
	22	--	103	---	253	--	15
C-2	4	8	11	40	0	2	0
	6	51	23	tr	62	tr	4
	8	114	129	419	114	22	tr
	11	800	645	1146	1119	33	41
	13	1108	827	2030	1519	27	46
	15	2114	1127	1886	2855	17	45
	18	3672	1577	2040	2305	24	47
	20	--	1435	---	1361	--	53
	22	--	1712	---	2648	--	24

*Means of four replications.

Table 3. Estimated production of cercosporin on a dry weight basis of mycelium...Trials I & II.

Isolate	Day	Cercosporin PDB (mycelium) I	Cercosporin PDB (mycelium) II
		(mg/g dry wt)	
C-1	4	0.30	0
	6	0.65	0.38
	8	1.25	0.88
	11	0.57	0.96
	13	0.85	1.56
	15	0.46	1.48
	18	0.47	0.69
	20	----	0.97
	22	----	0.66
C-2	4	2.41	0
	6	0	1.70
	8	4.03	1.37
	11	6.98	11.93
	13	7.91	7.75
	15	8.14	10.11
	18	5.60	7.60
	20	----	4.59
	22	----	8.12

Betagarin and betavulgarin in lesions from Cercospora-infected sugarbeet leaves.--S. S. Martin.

From field-grown sugarbeets of 6 cultivars spanning the range of resistance and susceptibility to *Cercospora beticola*, duplicate random samples of 50 composited mature lesions were taken from each of two replications at 3 dates after artificial inoculation with the fungus. Both betagarin and betavulgarin content per lesion differed significantly among cultivars. Across cultivars, however, betavulgarin content differed at the 3 sampling dates (corresponding to varying degrees of disease development), whereas betagarin content did not (Table 1). The date of sampling X cultivar interaction was not significant for either compound.

The mean betavulgarin content at the second sampling date, 14.5 μg/50 lesions, corresponds to about 200 μg/cc. *In vitro* bioassay data showed that a betavulgarin concentration of about 100 μg/cc of medium inhibited linear (diameter) growth by 50% (corresponding to a surface area reduction of about 75%, assuming growth is circularly uniform). Although the appropriateness of extrapolation from *in vitro* measurement to a very different *in vivo* nutritional environment must always be uncertain, these data suggest that the amounts of betavulgarin present in lesions are potentially fungistatic and could be involved in limitation of the pathogen.

Table 1. Betagarin and betavulgarin contents of lesions at three dates after inoculation of sugarbeet leaves with *Cercospora beticola*.

Sampling date*	Mean disease rating	Mean content, µg/50 lesions[1] Betagarin	Betavulgarin
t_o + 3 weeks	1.0	44.2 a	8.9 b
t_o + 6 weeks	2.8	33.9 a	14.5 a
t_o + 9 weeks	4.5	31.4 a	5.1 c

*t_o = date of artificial inoculation with *C. beticola*.

[1]Within columns, means followed by the same letter did not differ significantly by Duncan's multiple range test at p = 0.05.

Correlation coefficients for betagarin and disease rating at the three sampling dates were all positive but statistically nonsignificant, and those for betavulgarin and disease rating were invariably negative but nonsignificant. The lack of correlation between betavulgarin and disease rating does not negate its possible role as a phytoalexin, for several reasons. First, betavulgarin content among the cultivars was within a narrow range, which would make it almost impossible to detect correlation even if it were present. Second, disease rating is an attribute of the whole plant or even of an entire plot of diseased plants of a given genotype, whereas the chemical analyses are of discrete individual lesions. It is possible that betavulgarin might be involved in fungal limitation within the lesion, but that other factors could determine the number of lesions initiated and therefore the overall disease effect on the genotype. Third, in these field studies there could be no control of the repeated cycles of infection by newly germinated spores; therefore, there was no possibility of knowing the realtive age of the "mature" lesions sampled. Work is in progress to examine the time course of accumulation of betagarin and betavulgarin in lesions of more closely known age.

Electron Microscopy of Cercosporin-Induced Necrotic Lesions on Sugarbeet Leaves.--M. P. Steinkamp and S. S. Martin.

Necrotic lesions can be induced on sugarbeet leaves by external application of cercosporin, one of the toxins isolated from culture filtrates of *Cercospora beticola*. Initial electron microscopic examination of cercosporin-induced lesions showed a degenerative sequence with much similarity to that of the fungus-induced lesion (described in 1975 Sugarbeet Research Report, p. C28). Intercellular spaces contain areas of finely granular, medium electron-dense material resembling extracellular material in the actual disease. There are areas of appositional layers inside cell walls but outside the plasmalemma; like those of the fungus-induced disease, they are variable in appearance from place to place. Organelles are altered internally, then lose their boundary membranes. Mitochondrial cristae appear to be differently and more rapidly altered in cercosporin-induced lesions than in the disease. Ultimately the toxin-induced necrotic cell, like the fungus-induced necrotic cell, is collapsed and filled with amorphous cytoplasmic remains and areas of dissolution. Further investigation is planned of the degenerative process in both cercosporin-induced lesions and those induced by another *Cercospora* toxin.

Efficacy of Cycloheximide ('Acti-Dione') in Controlling Cercospora beticola In Vitro and In Vivo.--E. G. Ruppel.

Concentrations of 10 ppm (µg active ingredient/ml) or more of cycloheximide were needed to cause 50% growth inhibition of four *C. beticola* isolates in culture. When sugarbeet plants were sprayed with the antibiotic, inoculated with *C. beticola*, and placed in a humidity chamber, as little as 2 ppm caused excessive phytotoxicity of the foliage. Thus, this chemical is not recommended for control of leaf spot in sugarbeet.

RHIZOCTONIA ROOT ROT RESEARCH, 1976

Rhizoctonia Resistance, Field Research, 1976.--R. J. Hecker and E. G. Ruppel.

The 1976 field experiments that were a part of our rhizoctonia research program were conducted on our BSDF-leased farm where we also conduct our cercospora leaf spot field research. This was the fourth crop year of the 5-year lease on the farm.

Except for the selection blocks, which were rosette-inoculated, the entire field was broadcast-inoculated with a tractor-mounted 4-row granular-materials applicator. The dry, ground barley-grain inoculum of *Rhizoctonia solani* (R-9) was broadcast in a band over each row at a rate of 12 grams per 20 foot of row in a split application (opposite direction of travel for each application). One-row plots 20 feet long and 22 inches apart were planted May 11. Thinning was done between June 11 and June 22, and the experiments were inoculated July 14. The roots were lifted and individually rated for severity of root rot September 21 through 23. The disease index (DI) ratings were based on a scale of 0 to 7 (0 = no evidence of infection, 7 = plant dead and extensively decomposed). The percentage of healthy roots (DI ratings 0 and 1 combined) also was calculated.

Our rhizoctonia root rot epidemic in 1976 was very severe. It was too severe for good separation of susceptible and moderately resistant lines. We will attempt to achieve a more modest epidemic next year by reducing the inoculum rate and possibly by allowing a longer growth period between planting and inoculation. The DI range of breeding lines tested was 3.4 to 7.0 (most resistant to most susceptible) in 1976, whereas in 1975 the range was 1.7 to 6.7. The intensity of infection in 1975 was almost ideal.

The data for percentage of healthy roots in 1976 is less useful than in 1975, since the range is narrow, and most of the relatively susceptible lines have essentially no healthy plants. The 1976 DI data are reliable but less discriminating than in 1975.

Breeding for Rhizoctonia Resistance.--R. J. Hecker and E. G. Ruppel.

We are continuing to make a significant effort in breeding for increased resistance to rhizoctonia root rot. Our breeding scheme involves both mass selection and recurrent selection for general combining ability for resistance. Since resources are limited, only the most promising lines are included in recurrent selection. New and less promising lines are carried in the mass selection program. Each year lines which fail to respond to selection are deleted or shifted from recurrent to mass selection, whereas lines with new found promise are added into the mass or recurrent selection program. A few new untested lines (usually diverse or exotic) are tested each year. In 1976, the first line has been found which appears to have a significant degree of inherent resistance (see entry 457, Table 1). This red tester beet is being incorporated into the breeding program. We know from previous tests, however, that resistance and root color are unrelated. We also have made crosses among our more promising lines in an attempt to isolate transgressive segregants for resistance.

Our most resistant lines are evaluated each year for combining ability and for sugar yield in an attempt to identify lines which may have potential as parents of hybrids.

Over the past decade, 15 rhizoctonia-resistant breeding lines have been made available to BSDF members. These have all been multigerm. Resistance in monogerm germplasm has been developed (see entries 451 and 452, Table 1) after many disappointments in our breeding effort. From this germplasm will come the first monogerm, type O and cytoplasmic male sterile lines with rhizoctonia resistance.

In addition to several hundred progeny line evaluations in 1976, over 50 breeding and miscellaneous lines were compared for resistance (Table 1). Under the severe epidemic of 1976, it is clear that we are not yet approaching complete resistance, even in our best lines. However, this may be an unattainable and unnecessary goal. Meanwhile, we will continue the breeding effort based on the evidence that more resistant genetic recombinations are possible and can probably be isolated. Release of the most promising breeding lines is anticipated during 1977.

Table 1. Rhizoctonia root rot resistance of breeding and miscellaneous lines assessed by disease index (DI) and % of check and % healthy roots. Means followed by the same letter are not significantly different (P = .05).

		DI		
Entry no.	Population and description	Mean	% of check	% healthy
Multigerm lines				
441	FC 701/5; 7 cy.Rh.sel	4.2 ghij	93	22
442	FC 703/1; increase	4.3 fghij	91	24
443	FC 702/5; 7 cy.Rh.sel.	5.0 def	68	20
444	FC 701/5; 6 cy.Rh.sel.	4.7 defg	76	19
445	FC 701/4; 7 cy.Rh.sel.	4.3 fghij	89	23
449	FC 701/5; 7 cy.Rh.sel.;increase	4.2 ghij	95	22
467	FC 702/5; Syn., 7 cy.Rh.sel.	4.4 efghij	87	19

Table 1 continued

Entry no.	Population and description	DI Mean	DI % of check	% healthy
Multigerm lines				
468	FC 701/5; Syn., 7 cy.Rh.sel.	4.4 fghij	88	20
469	FC 703; resistant check	4.0 hij	100	18
471	FC 703; syn. from GH Rh.sel.	4.7 defgh	76	22
446	Rh.resist. line from misc. incl. B. maritima	5.3 cd	56	4
447	Rh. damp-off sel. from FC 700's	4.5 efghij	85	18
448	Rh. trans. segs. from FC 702/5 X FC 701/5	4.3 fghij	92	23
450	Rh.sels. by Afanasiev from GW material	6.6 ab	12	0
454	GH Rh.sel. from SP 6322-0; 1 cy.	6.7 ab	11	4
472	Syn. of GH Rh.sel. from SP 6322-0; 1 cy	6.3 ab	24	6
455	SP 6322-0	6.8 a	5	0
456	Syn. Red	5.0 def	68	19
457	Red Beet Tester	4.0 ij	100	28
466	Syn. fr. GW 674 and C 817	3.8 j	109	29
474	SP 7322-0	6.6 ab	12	4
453	C 17	7.0 a	0	0
459	VNIS-F-505; USSR, trench rot res.	6.8 a	6	0
460	VNIS-F-510; USSR, trench rot res.	6.7 ab	10	0
461	VNIS-F-526; USSR, trench rot res.	6.6 ab	12	0
462	VNIS-F-738; USSR, trench rot res.	6.5 ab	18	0
463	N 7776; USSR	6.5 ab	18	6
476	Pool of 14 MM USSR lines	6.9 a	4	0
Monogerm lines or segregating for monogerm				
451	Syn. from FC 701 X LSR-CTR, Type O, mm lines	3.4 k	122	35
452	F_3 families from FC 701 X LSR-CTR, TO, mm	4.4 fghij	88	22
458	LSR-CTR,mm X FC 701 B_1OP_1; 2 cy. Rh.sel.	6.0 bc	33	7
465	Syn. from 702 X LSR-CTR, mm	4.8 defg	73	16
464	SP 555-0	6.5 ab	18	8
483	SP 547-0	6.7 ab	11	5
475	Pool of 4 USSR mm lines	6.7 ab	10	2
477	Mono Hy A1	6.6 ab	12	0
478	Mono Hy D2	6.5 ab	17	2
479	HH-21	6.9 a	3	0
480	Amer. #2 Hyb. B	6.7 ab	9	2
481	US H20	6.9 a	2	0
482	US H10B	6.9 a	3	2
485	U-I Hyb. 8	6.9 a	4	0
488	AH-10	6.9 a	2	0
492	ACH 12	6.9 a	2	0
493	ACH 14	6.8 a	6	0

Evaluation of Contributed Lines.--E. G. Ruppel and R. J. Hecker

Separate randomized block designs with five replications were used to evaluate lines from Amalgamated, American Crystal, Great Western, and Holly Sugar Companies for resistance to *Rhizoctonia*. Lines from Utah-Idaho Sugar Company were included in another experiment of similar design, but with 52 additional USDA entries. A total of 77 contributed lines were tested. Resistant cultivar FC 703 was included as a control in each test. Results of each company's test were statistically analyzed and sent to company breeders, thus, they will not be reproduced here. Generally, the resistant control and hybrids with resistant parentage (FC 701, 702, or 703) were more resistant than entries having no history of selection or breeding for rhizoctonia resistance. The disease index range on a scale of 0 to 7 for cultivar FC 703 was 3.5-4.4 ($\bar{x}$ = 4.0), whereas for company lines the range was 3.4-7.0 ($\bar{x}$ = 6.2). Percentage healthy roots (0 + 1 classes) for FC 703 ranged from 9-26 ($\bar{x}$ = 15.6)%, whereas for the other entries the range was 0-32 ($\bar{x}$ = 2.9)%.

Effect of a Nematicide ('Telone II') and a Systemic Insecticide ('Temik') on Intensity of Rhizoctonia Root Rot in the Field.--E. G. Ruppel, R. J. Hecker, and C. R. Frey.

Neither preplant 'Telone' fumigation nor 'Temik' application, alone or in combination under quasi-commercial conditions, affected the incidence or severity of root rot in cultivar Mono Hy D2 in a field experiment. Mean disease indexes for all treatments including the nontreated control ranged from 6.5 to 6.8 on a scale of 0 to 7.

Effect of Nitrogen Fertility Level on Intensity of Rhizoctonia Infection in the Field.--E. G. Ruppel and R. J. Hecker.

Nitrogen fertility (preplant and side-dressed) had no significant effect on the overall severity of root rot in a susceptible sugarbeet hybrid variety planted in a field infested with *Rhizoctonia solani*; however, significantly more roots were classed as healthy when beets received 180 vs. 80 lb N/acre (13 vs. 3%, respectively).

Efficacy of 2-Iodobenzanilide ('Benodanil') for Control of Rhizoctonia Root Rot.--E. G. Ruppel, E. E. Schweizer, and C. R. Frey.

An in-furrow application of 5 and 10 lb product per acre failed to control *Rhizoctonia solani* in the field, but did control the disease in a greenhouse experiment. This product has been discontinued by BAS and no further tests will be made.

Root Rot Severity at Different Harvest Dates.--E. G. Ruppel and R. J. Hecker.

Disease severity in our rhizoctonia nursery was not dramatically different over three harvest dates at 10-day intervals beginning September 7. Mean disease indexes (D.I.) on a scale of 0 to 7 for cultivars FC 701/5 (resistant), FC 801 (intermediate), and FC 901 (susceptible) on September 7 were 3.3, 4.7, and 6.4, respectively. At the last harvest on September 28, the D.I.'s were 3.8, 5.6, and 7.0, respectively. Thus, considerable latitude exists for scheduling field evaluations for disease resistance.

Susceptibility of Species in the Section Patellares to Rhizoctonia solani.--E. G. Ruppel.

Beta atriplicifolia, B. macrocarpa, B. maritima, and *B. vulgaris* [Swiss chard, and sugarbeet cultivars FC 901 (susceptible) and FC 701/5 (resistant)] were tested for susceptibility to the seedling damping-off and mature root rot phases incited by *Rhizoctonia solani*. Mean disease indexes on a scale of 0 to 7 ranged from 4.6 to 5.6 for all entries, excluding FC 701/5 which had a mean of 1.7.

Triploid vs. Diploid Hybrids for Rhizoctonia Resistance.--R. J. Hecker and E. G. Ruppel.

Somewhat limited data in 1973 and 1974 indicated that 3X hybrids, where the rhizoctonia resistant pollinator was tetraploid (4X), were more resistant to a root-rotting strain of *Rhizoctonia solani* than were equivalent 2X hybrids. However, no difference was noted between 2X and 4X equivalent resistant parents. In 1976, 36 hybrids were compared in more extensive confirmatory experiments.

In Table 1 are listed disease index (DI) means for hybrids with common pollinators and common CMS parents, as well as the parents themselves. There appears to be no doubt that 3X hybrids with two genomes from the resistant pollinator are more resistant to rhizoctonia root rot than similar 2X hybrids.

There appears to be some interaction with CMS parents. In Table 1, 2X and 3X hybrids with (562 CMS X 569) and 63-(5HO X 6) were not significantly different. Hence, significant advantage of 3X over 2X hybrids may not occur for every CMS line, but at least there appears to be no disadvantage for resistance.

There is one significant parental difference, FC 701/4 vs. FC 701/4(4X), where the 4X is more resistant than its 2X source. This appears to be an exaggeration of a nonsignificant difference shown in 1974. If this is a real genetic difference due to genetic drift, unobserved natural selection, or undetected pollen or seed contamination, it would have biased some of the results in favor of the 3X hybrids. But the pollinator effects of FC 703 and FC 702/4 in Table 1 would be unaffected. So it detracts little from the credibility of the results.

Table 1. Mean disease index (DI) of hybrid combinations of six CMS lines and three rhizoctonia resistant 2X and 4X pollinators.

Pollinator effects	Mean DI	
CMS lines X FC 703	5.9	}**
CMS lines X FC 703 (4X)	5.5	
CMS lines X FC 701/4	6.1	}**
CMS lines X FC 701/4 (4X)	5.3	
CMS lines X FC 702/4	6.3	}**
CMS lines X FC 702/4 (4X)	5.2	
CMS lines X 2n ♂'s	6.1	}**
CMS lines X 4n ♂'s	5.3	
Female effects		
Polish 300/71 CMS X 2X ♂'s	6.3	}**
Polish 300/71 CMS X 4X ♂'s	5.3	
(562 CMS X 569) CMS X 2X ♂'s	5.9	}NS
(562 CMS X 569) CMS X 4X ♂'s	6.0	
63-(5HO X 6)CMS X 2X ♂'s	5.4	}NS
63-(5HO X 6)CMS X 4X ♂'s	5.0	
GW 918 CMS X 2X ♂'s	6.2	}**
GW 918 CMS X 4X ♂'s	5.4	
H65-02-69 CMS X 2X ♂'s	6.3	}**
H65-02-69 CMS X 4X ♂'s	5.2	
(100363 X 12166)CMS X 2X ♂'s	6.3	}**
(100363 X 12166)CMS X 4X ♂'s	5.5	
Parent lines		
Polish 300/71 CMS	7.0	
(562 CMS X 569) CMS	6.8	
63-(5HO X 6) CMS	6.5	
GW 918 CMS	6.8	
H65-02-69 CMS	6.8	
(100363 X 12166) CMS	6.8	
FC 703	3.9	}NS
FC 703 (4X)	3.6	
FC 701/4	5.1	}**
FC 701/4 (4X)	3.1	
FC 702/4	4.8	}NS
FC 702/4 (4X)	4.3	

LSD .05 = 0.83 (for comparison of parents)

The CMS parent 63-(5HO X 6) imparts a significant amount of resistance into some of its hybrids and may be worthy of testing as a parent of hybrids in a rhizoctonia prone area.

These data, together with those of 1973 and 1974, confirm the resistance advantage of 3X hybrids with two resistant genomes over 2X hybrids. Hence, breeders desiring resistance in their hybrids should use a 4X rhizoctonia resistant pollinator.

POWDERY MILDEW INVESTIGATIONS, 1976

Sugarbeet Powdery Mildew in 1975-76.--E. G. Ruppel.

Powdery mildew followed the same pattern of development and spread as noted in the past 2 years. The disease occurred in every area where sugarbeets are grown, including experimental tests in Beltsville, MD. Control of the disease has continued with timely applications of sulfur in various formulations.

Resistance of Beta patellaris and B. procumbens to the Sugarbeet Powdery Mildew Fungus.--E. G. Ruppel.

No powdery mildew developed in 53 plants of *Beta patellaris* from four seed lots, or in 12 plants of *B. procumbens* following inoculation with powdery mildew fungus conidia from sugarbeet. All plants were maintained in an atmosphere conducive to powdery mildew development, and in the presence of infected sugarbeet plants, until they flowered and set seed. Thus, these *Beta* spp. appear to be highly resistant to *Erysiphe polygoni* from sugarbeet.

Relationship of Plant Age and Susceptibility of Sugarbeet to Powdery Mildew. --E. G. Ruppel.

A randomized block design with four replications was used in each of two trials to determine relative susceptibility of sugarbeet at 2, 4, 8, 12, and 16 weeks after planting. Disease severity increased with age of plant at inoculation. Mean disease indices on an increasing severity scale of 0 to 5 from a combined analysis were 3.5 for 16-, 2.5 for 12-, 1.8 for 8-, 0.7 for 4-, and 0.3 for 2-week-old plants.

The Effect of Quick-Freezing on Viability of Powdery Mildew (Erysiphe polygoni) Conidia.--E. G. Ruppel.

Heavily infected sugarbeet leaves were quick-frozen and then held at -33 C for 24, 48, 72, and 96 hours. After each period, a sample of frozen leaves was ground and used to inoculate sugarbeets. Conidia from frozen samples also were distributed on water agar and incubated for 16 hours at 25 C to determine viability. All inocula prepared from frozen leaves were noninfectious, and conidia failed to germinate on water agar.

Additional Studies on Powdery Mildew.--E. G. Ruppel.

1. Cycloheximide at 2 ppm was shown to effectively control sugarbeet powdery mildew in a greenhouse test. However, the antibiotic caused significant phytotoxicity and cannot be recommended for use on sugarbeet.

2. Powdery mildew spores (*Erysiphe* sp.) from naturally infected field plants of *Amaranthus retroflexus* failed to infect sugarbeet in the greenhouse. Spores from sugarbeet also failed to infect healthy *A. retroflexus* plants.

3. Experiments on the longevity of powdery mildew spores and mycelium on infected sugarbeet leaf debris and seed were repeated and confirmed in 1976 (these reports, 1975, p. C29-C30).

SUGARBEET RESEARCH

1976 Report

Section D

North Dakota Agricultural Experiment Station, Fargo, North Dakota

Dr. W. M. Bugbee, Plant Pathologist
Dr. D. F. Cole, Plant Physiologist

Cooperation:

American Crystal Sugar Company
Minn-Dak Sugar Cooperative
Minnesota Agricultural Experiment Station
North Dakota Agricultural Experiment Station
Sugarbeet Research and Education Board of
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CONTENTS

Abstracts of manuscripts approved for publication:

1. Bugbee, W. M. and D. F. Cole. 1976. Sugarbeet storage rot in the Red River Valley, 1974-75. J.ASSBT 19: 19-24.

   Sugarbeet roots were sampled from the picking table at a Moorhead, MN, factory from November 6, 1974, through March 12, 1975. During this 128-day period 1.22% by weight of roots processed were rotted. This amounted to an actual sugar loss of 1,113,240 lb plus another loss estimated at 1,781,184 lb of sucrose going to molasses (1.6 melassigenic factor). About 71% of the roots were partially crowned. This practice probably contributed to rot development. A sampling of roots from the Red River Valley showed that the amounts of crown removed and decay were similar among six factories. Three fungal pathogens were involved: _Phoma betae_, _Penicillium claviforme_, and _Botrytis cinerea_. The prevalence of _P. betae_ was slightly greater than of _P. claviforme_. Both were much more prevalent than _B. cinerea_.

   There was slightly more rot, associated with wounds, on the tap root than on the crown early in the storage period. Rot in the crown region developed slowly but eventually accounted for the greatest portion of rotted tissue compared to the tap root or tip of the tap root.

2. Bugbee, W. M. 1976. _Penicillium claviforme_: sugar beet pathogen and antagonist of _Botrytis cinerea_. Can. J. Plant Sci. 56: 647-649.

   Sugar beet storage rot caused by _Botrytis cinerea_ was completely inhibited by a storage rot isolate of _Penicillium claviforme_ in sugar beet tissue. Storage rot caused by _Phoma betae_ was not inhibited. Growth of _B. cinerea_ was inhibited 50-100% in liquid cultures containing diluted filtrates of _P. claviforme_. Differing reports as to the prevalence of _B. cinerea_ as a storage rot pathogen may be due to this antagonism.

3. Cole, D. F. and Bugbee, W. M. 1976. Genetic and other factors affecting internal CO_2 concentration in sugar beet roots. Can. J. Plant Sci. 56:627-631.

   Studies were conducted to determine if there was genetic variation in internal CO_2 levels in sugar beet roots during storage and to determine the effects of resident bacteria, storage temperature, decay, and root weight on internal CO_2 levels. Significant differences in internal CO_2 levels were observed among different sugar beet lines. Internal CO_2 levels of roots selected from American 3 Hybrid T were not correlated with the number of resident bacteria or weight of the roots after two storage periods. Root weight was negatively correlated with internal CO_2 over all lines and the coefficient of determination was 2.2% (r^2x 100). Internal CO^2 levels in roots with visible decay were significantly higher (5.21%) than CO_2 levels (1.92%) in healthy roots. Higher storage temperature significantly increased internal CO_2 levels in sugar beet roots. Our results show that there is genetic variation for internal CO_2 levels in sugar beet roots.

4. Cole, D. F. and W. M. Bugbee. 1976. Changes in resident bacteria, pH, sucrose, and invert sugar levels in sugarbeet roots during storage. Applied and Environmental Microbiology, May, 1976, 31: 754-757.

Stored sugarbeet roots began fermenting within 24 h after oxygen was depleted at 26 C when the resident bacterial populations increased dramatically. Most of the bacteria present after anaerobic storage for 7 days at 26 C could hydrolyze sucrose in vitro. Although pH and sucrose levels decreased and invert sugar levels increased with time in aerobic storage at 26 C, these processes were significantly accelerated in beets stored anaerobically at 26 C. Under oxygen-depleted storage conditions at 26 C, the sucrose content was almost completely lost after 21 days.

5. Cole, D. F., A. G. Dexter and Armand Bauer. 1976. Effect of agronomic practices on apparent sucrose and invert sugar levels during storage of sugarbeets (Beta Vulgaris L.). Farm Research 33:25-27.

The objectives of this study were to determine the effects of chemicals, supplemental irrigation, nitrogen, and cultivars on invert sugar accumulations and apparent sucrose loss in sugarbeet roots stored for 150 days at 5 C. The data indicate the importance of controlling several agronomic practices that affect quality of sugarbeet roots during storage.

6. Cole, D. F., A. D. Halvorson, G. P. Hartman, J. D. Etchevers, and J. T. Moraghan. 1976. Effect of nitrogen and phosphorus on percentage of crown tissue and quality of sugarbeets. Farm Research 33:26-28.

The objectives of this investigation were to determine the effects of nitrogen and phosphorus on the amount of crown tissue produced and quality of sugarbeets (Beta vulgaris L.) grown in the field. Nitrogen and phosphorus significantly increased the percentage of crown tissue produced. Nitrogen significantly lowered sucrose concentration in root and crown tissue. Phosphorus did not affect sucrose in crown tissue, but 80 lbs P/acre significantly lowered sucrose in root tissue. These results suggest that good management of soil fertility can significantly improve sugarbeet quality by reducing the amount of crown tissue produced and by reducing impurities that influence extraction of sucrose.

SUGARBEET STORAGE ROT RESEARCH

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The use of a sugarbeet storage variety that has been developed for highly desirable storage characteristics might help us reduce losses in storage. One of these characteristics should be resistance to storage rot pathogens. One aspect of our breeding program is to identify genotypes with resistance to one or more storage rot pathogens and to increase the frequency of these genotypes so they can be used as parental material for the development of storage hybrids.

Sugarbeet roots are not evaluated for resistance to storage rot pathogens until the roots have been in storage for at least 80 days. Experience has shown us that freshly harvested roots are more resistant to rot than roots that have been stored for several weeks. Therefore, we wait until roots have been stored for 80 days before evaluation at which time susceptibility has increased considerably. The assumption is that little value will be realized unless resistance is at adequate levels in roots that have been stored for some time. If resistance could be detected earlier in the life cycle of the sugarbeet then progress in a breeding program could be accelerated because more roots could be evaluated in one year and susceptible material could be eliminated early in the program. This is the objective of this experiment.

Two sugarbeet lines, one selected for resistance to Phoma betae in the USA from a line of Russian origin and a second line which was a susceptible commercial cultivar, were harvested and evaluated for rot resistance 80, 121, and 162 days after planting and after 0, 30, or 80 days storage at 5 or 20^{o}C. Cores of root tissue, 18mm in diameter, were removed with a cork borer, placed on end on pure cultures of P. betae, Botrytis cinerea, or Penicillium claviforme, then incubated for 14 days at 20-22^{o}C. After incubation, the cores were cut longitudinally and given a rot rating.

Results and Discussion

The resistance to all pathogens of unstored roots increased with maturity. This supported our earlier observations. This was most evident with B. cinerea and P. betae and less so with P. claviforme. When the most immature roots (80 days after planting) were stored at 5^{o}C they became more resistant than those that had not been stored. These immature roots became more resistant to P. claviforme when stored at 20^{o} for 30 days but not after 80 days.

The rot reactions as affected by root maturity and storage conditions was not consistent among the three pathogens. The reactions to B. cinerea and P. claviforme of roots that had been stored for 30 or 80 days at 5^{o} were similar. Roots stored at 20^{o} for 80 days increased in susceptibility to B. cinerea. This increase was not evident with P. claviforme. The reactions to P. betae of roots of intermediate maturity (121 days after planting) differed from B. cinerea and P. claviforme. The susceptibility of these roots increased after 30 then decreased after 80 days in storage to a point comparable to unstored roots.

Varietal differences to infection were greater with *B. cinerea* than the other two fungi. These differences were evident in roots that were harvested 121 or 162 days, but not 80 days after planting. The varietal differences were greater after the roots had been stored.

A summary of the analysis of variance is in table 3. The single effects of genotype, maturity, and storage conditions were significant except for the effect of maturity on rot caused by *P. betae*. The effect of genotype on rot caused by *Penicillium* was significant at the 5% level but the means were so similar that differences probably could not be detected when actually screening roots. The interaction of genotype and maturity was not significant indicating these variables acted independently on rot caused by the three pathogens. The interaction of genotype and storage conditions was significant for rot caused by *Botrytis* and *Penicillium* but not *Phoma* indicating that these factors acted independently on *Phoma* but interacted to influence the amount of rot caused by the other two pathogens. Maturity and storage conditions interacted to affect the amount of rot caused by all pathogens. The second order interaction of all three factors affected the amount of rot caused by *Phoma* and *Botrytis* but not *Penicillium*.

At least one more year's data is needed to support the conclusions that detecting resistance to *Botrytis* can be done with immature stored roots; to *Penicillium* in mature unstored roots; and to *Phoma* in mature stored roots.

Progress in Breeding for Resistance to Three Storage Rot Pathogens

Table 2 lists most of the entrys from the 1976 storage rot evaluation. Introductions from the U.S.S.R. that were developed for resistance to storage rot did not have adequate levels of resistance to our isolates of storage pathogens. But selections of roots showing resistance within these populations have resulted in good progress in developing germplasm with significant levels of resistance especially to *B. cinerea*. Three of the best Russian lines are 768 (75B2-1), 7613 (75B1-1), and 7615 (75B3-7). The entry 75P2-4 has the highest percentage of roots resistant to *P. betae* and originated from FC701/4, a rhizoctonia crown rot resistant line from ARS, Ft. Collins.

The disposition of these four germplasms is pending results of the current (1977) evaluation.

Table 1. Effect of root maturity and length and temperature of storage on decay caused by three storage pathogens. Two lines were compared, one selected for resistance (R) to *Phoma betae* and the other susceptible (S) a commercial cultivar.

Phoma betae

Rot Reaction	Storage time	Storage temp.	Age at Harvest (days) 80	121	162
	days	°C	rot rating a/		
S	0	--	2.6	1.4	0.9
S	30	5	0.7	2.7	1.2
S	30	20	2.0	2.7	0.9
S	80	5	1.6	0.8	3.2
S	80	20	4.8	1.9	5.0
R	0	--	2.1	1.2	0.8
R	30	5	0.3	2.2	1.2
R	30	20	1.4	2.2	1.4
R	80	5	1.4	0.9	1.8
R	80	20	4.0	1.7	4.1
		Botrytis cinerea			
S	0	--	5.0	2.7	1.0
S	30	5	4.6	3.9	3.4
S	30	20	5.0	3.0	3.8
S	80	5	4.3	3.3	5.1
S	80	20	5.6	4.2	4.9
R	0	--	5.0	1.4	0.4
R	30	5	2.4	1.7	1.8
R	30	20	3.2	2.2	2.2
R	80	5	2.0	1.5	3.4
R	80	20	4.3	3.4	4.3
		Penicillium claviforme			
S	0	--	3.4	0.6	2.8
S	30	5	0.1	2.8	2.7
S	30	20	1.8	2.2	2.2
S	80	5	1.6	2.8	3.1
S	80	20	4.3	2.8	5.0
R	0	--	3.1	1.1	2.7
R	30	5	0.3	2.6	2.6
R	30	20	1.5	2.3	2.4
R	80	5	1.4	2.4	2.3
R	80	20	3.3	2.2	4.4

a/ rot rating; 0, 1 = resistant; >2 = susceptible

Table 2. Results of 1976 evaluation of sugarbeet roots for resistance to storage rot caused by Phoma betae, Botrytis cinerea, and Penicillium claviforme. The original line is compared to progeny from individual plants of an interpollinated population.

Source		No. of Roots (n)	% of n resistant to Phoma	Botrytis	Penicillium	
FC 701/4	691246-00	80	11	0	4	1975 began recurrent selection. Seed for this crop derived from 2 cycles of individual plant selection for resistance to Phoma. 691246-00 from Fort Collins crown rot program.
75P2-1	Ft. Collins	62	19	0	0	
75P2-2		56	23	0	0	
75P2-3		37	62	0	0	
75P2-4		41	71	0	2	
75P2-5		59	66	0	0	
75P2-6		52	67	0	0	
75P2-7		36	75	0	0	
75P2-8		48	17	0	2	
75P2-9		47	21	0	0	
70P23	East Lansing	52	0	0	0	1975 began recurrent selection. Seed for this crop derived from 3 plants selected for resistance to Phoma. In 1974 70P23 from East Lansing.
75P4-1		23	9	26	0	
75P4-2		68	1	6	0	
75P4-3		84	4	2	0	
75P4-6		30	3	10	3	
75P4-7		6	17	0	0	
75P4-8		32	0	0	0	
75P4-9		6	0	33	0	
75P4-11		8	0	12	12	
75B4-1		23	0	0	0	
75B4-2		34	3	0	0	
75B4-3		24	0	0	0	
75B4-4		20	0	0	0	
N2376		54	0	0	0	1975 first year of recurrent selection. Roots selected in 1975, N2376, F526, F738, F510, are Russian breeding lines resistant to 'trench rot' under their conditions.
75B1-1		70	46	51	7	
75B1-2		10	0	10	0	
75B1-3		75	40	25	1	
75B1-4		71	0	11	3	
75B1-5		82	15	21	1	
75B1-6		94	7	10	2	
VNISF526		79	15	0	4	
75B2-1		30	17	57	13	
75B2-2		94	0	3	2	
75P6		60	30	0	2	

Source		No. of Roots (n)	% of n resistant to Phoma	Botrytis	Penicillium	
VNISF738		68	15	0	0	
75P3-2		48	10	0	0	
75P3-3		64	44	0	12	
75P3-4		85	28	0	4	
75P3-5		67	36	0	0	
75P3-6		44	20	0	0	
75P3-8		26	15	0	4	
75B3-1		76	1	1	3	
75B3-2		39	0	15	0	
75B3-3		38	3	0	10	
75B3-4		33	0	15	3	
75B3-5		23	13	30	4	
75B3-7		82	46	38	12	
75B3-8		108	37	42	9	
VNIS F510	U.S.S.R.	63	2	2	2	Mass selection
75B7		136	37	0	1	method.
Bot 3-6		66	24	42	0	
7327-1	FC 702	77	17	0	0	
	Ft. Collins					
SRS7319-1	FC702/4	39	0	0	0	
75P1	711245HOO	44	9	0	0	
75P5	73097H	48	33	0	4	
EL 101	Botrytis res	28	28	7	4	Selected for R or S
EL 102	Botrytis sus	33	12	6	0	to Botrytis in 1966,
EL 103	Botrytis res	26	31	27	0	East Lansing.
EL 104	Botrytis sus	13	31	0	0	
EL 105	Botrytis res	33	21	9	0	
EL 106	Botrytis sus	17	6	6	0	
FCB 107	582027-0	31	0	3	0	Early selection at
FCB 108	621000-0	68	0	0	0	Fort Collins for
FCB 109	621001-0	62	10	2	0	R to Botrytis.
FCB 110	651112-0	75	24	3	3	

Table 3. Summary of analysis of variance for the effect of root maturity, host reaction, and storage conditions on storage rot.

Source of Variation	Phoma	Pathogens Botrytis	Penicillium
genotype (G)	**	**	*
root maturity (M)	NS	**	**
storetime & temp (STT)	**	**	**
GxM	NS	NS	NS
GxSTT	NS	**	**
MxSTT	**	**	**
GxMxSTT	**	*	NS
C.V., %	35	20	25

SUGARBEET PHYSIOLOGY

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During the 1975-76 storage period, severe difficulties were experienced with the operation of the cold storage facilities of the Sugarbeet Research Center on NDSU campus. Several experiments were being conducted for the second year. However, due to the lack of temperature control, most of the experiments were terminated. No information on the effects of growth regulators, simulated hail damage, and delayed harvesting after scalping on post-harvest storage losses was obtained. These experiments are being repeated in the 1976-77 storage period.

This report contains information on some of the other physiology studies being conducted by the Agricultural Research Service.

Effect of Complete Defoliation on Yield and Sucrose

Sugarbeets were grown on the North Dakota State University Experiment Station at Fargo. Seed of 'American 2 Hybrid B' were planted on June 7 and May 21 in 1974 and 1975, respectively. Seed was planted at the American Crystal Research Station in Moorhead on May 10, 1976. Individual plots consisted of 4 rows spaced 22 inches apart and 35 feet long. Plots were arranged in a randomized complete block design with 6 replications.

Simulated hail "damage" was accomplished by cutting off all leaves with a razor blade or hand scythe (depending on plant size) near the base of the petioles. Leaf removal was initated 15 days after planting and continued at approximately 15 day intervals until 30 days before harvest in 1974 and 1975. In 1976, defoliation treatments were initated in July and continued for 50 days at 10-day intervals. Plants within each plot were damaged only once during the growing season, except the plants in the check plots which were not damaged.

Sugarbeets were harvested on October 3, 15, and 19 in 1974, 1975, and 1976, respectively. Prior to harvest, 5' alleyways (reducing plot length to 30') were established between plots by hand digging and discarding the roots. The plots were flailed with a commercial rotobeater and the entire 4-row plot was harvested with a modified 2-row mechanical lifter in 1974 and 1975. Small roots were picked by hand. In 1976, the two center rows were harvested by manual methods.

After harvesting, the roots were washed, weighed, and quality determinations were made using pulp obtained with a multiple blade saw from 10 roots selected at random from all roots within each plot.

Yield and sucrose content was significantly affected by the defoliation treatments (Figs. 1 and 2).

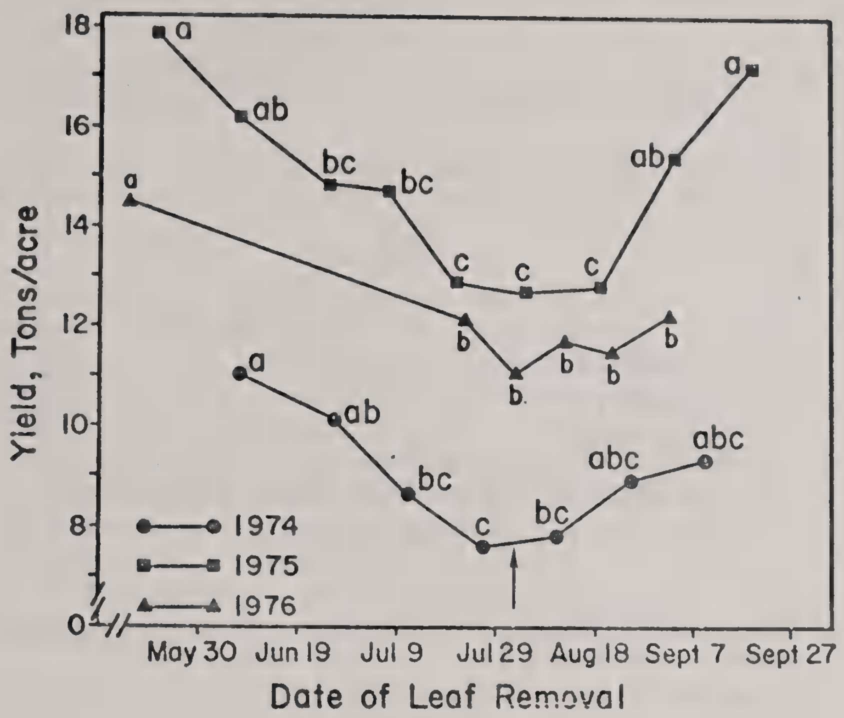

Figure 1. Effect of complete defoliation on yield of sugarbeet roots.

Late July and early August is the most critical period in sugarbeet growth for yield reduction by hail or other factors which may cause defoliation, since the lowest yields were obtained from plots that were defoliated during this period. Maximum reduction in gross sugar/acre also occurred during the late July early August growth period (Fig. 3).

In 1974 a severe hailstorm occurred on August 1 at Fargo and leaves on all plots were severely damaged. In both 1974 and 1975 the plants were not severely stressed by lack of moisture. The plots in 1976 were stressed due to a lack of adequate rainfall during the growing season.

The data reported indicate that partial damage by hail early in the growing season (prior to early July) would be slight, provided the terminal buds were not damaged. Maximum reduction in gross sugar would occur if severe hail damage occurred in early August.

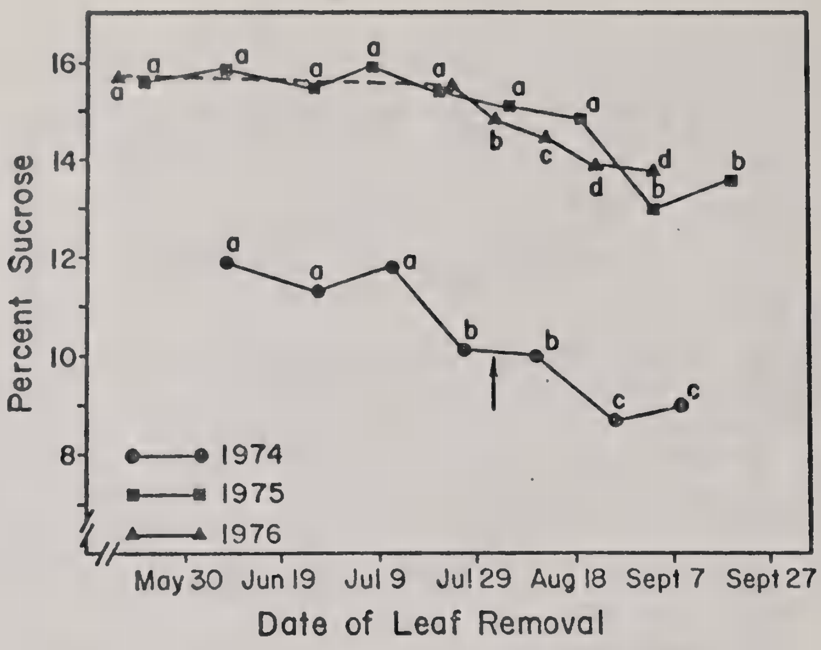

Figure 2. Effect of complete defoliation on percent sucrose in sugarbeet roots.

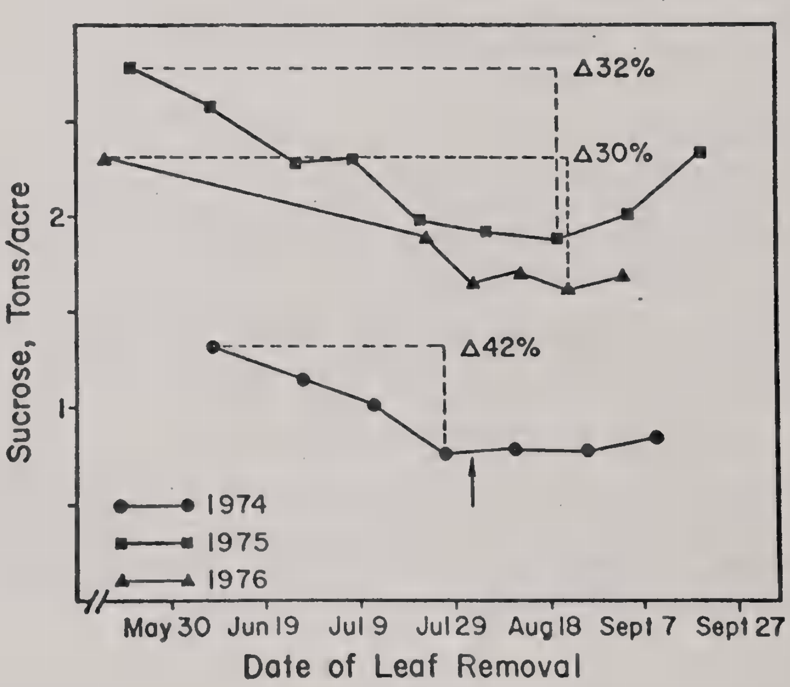

Figure 3. Effect of complete defoliation on gross sugar per acre.

Survey of Piler Stations

A survey of growers to determine the amount of crown material produced and the amount of crown removed by the grower was reported in the 1975 Sugarbeet Research and Extension Reports. Also included was a brief analysis of the amount of crown material delivered to the factory.

In 1976, a survey of piler locations was conducted to determine the amount of crown material delivered by the grower and to determine the effect of crown material on quality.

Eighteen locations were surveyed in mid-October. Fifteen consecutive truck loads across the piler was used to sample each location. Two tare samples were obtained with the automatic sample on the piler from each load. One sample from each load was used to determine the weight of the crown material above the lowest scar that was delivered to the piler by the grower. The remaining sample was used to measure quality of the roots as delivered by the grower. Both samples were delivered to the American Crystal Tare Laboratory at East Grand Forks, Minnesota. The beets were washed, weighed, and pulp obtained to measure sucrose, nitrate and conductivity grade at the tare laboratory. At each piler location, crown material was pooled into a composite sample which was analyzed at the tare laboratory.

Crown material accounted for 20.8% of the total tonnage delivered by the growers (Table 1). The range in percent crown (17.1 to 24.5%) was similar to that found in 1975 (13.8 to 24.4). The average percent crown over all locations in 1975 was 20.5. The 1976 data confirms that the factories are presently processing substantial amounts of crown material. Percent crown material appeared to be influenced by the amount of soil moisture available for plant growth. Generally lower amounts of crown was present in the southern areas of the Red River Valley where moisture was substantially below normal compared to the middle and northern areas of the valley where rainfall was greater.

Removal of all the crown material did not significantly affect sucrose, nitrate grade, or conductivity grade averaged over all locations (Table 1). Sucrose, nitrate and conductivity grades were significantly affected by locations.

Sucrose content of the composite crown material was 10.5% less than the average for the sample which was entirely root material, whereas, nitrate and conductivity grades were 7 and 37% greater, respectively.

A significant relationship was noted between brei nitrate grade and percent crown which confirms the relationship observed in 1975 (Table 2). Also, a significant negative association was noted between percent crown and sucrose levels. Our data indicated that by controlling nitrogen application, the grower can minimize the amount of crown material produced and maximize sucrose content in both root and crown tissue (Fig. 4).

Table 1. Percent crown, sucrose, nitrate, and conductivity grade of sugarbeet roots from several piler stations in the Red River Valley

Location	Percent Crown	Sucrose, %			Nitrate			Conductivity		
		1+	2	Crowns	1	2	Crowns	1	2	Crown
Amenia	17.1	17.3	17.4	14.9	2.7	2.9	3	4.5	4.7	6
Casselton	19.7	17.2	16.9	15.7	3.0	3.0	3	5.3	4.7	6
Kindred	19.8	17.5	17.3	15.5	3.1	2.9	3	4.2	4.5	6
Comstock	19.4	16.6	17.1	14.8	3.1	2.8	4	4.5	4.1	7
Moorhead	21.0	17.2	17.3	15.2	2.5	2.3	3	3.9	3.8	7
Perley	23.3	16.5	16.9	13.6	3.1	2.9	3	4.0	3.33	5
Ada North	22.4	16.4	16.8	15.3	3.1	3.3	3	3.9	4.1	5
Ada West	21.8	16.7	16.7	14.9	3.4	3.3	3	4.6	4.1	6
Crookston South	22.6	17.1	17.0	14.8	2.7	2.9	3	3.7	3.7	5
Crookston North	24.5	16.0	16.3	14.3	3.4	3.5	4	4.1	4.1	5
East Grand Forks	23.1	16.3	16.5	15.3	3.5	3.5	4	3.8	4.0	6
Hillsboro North	21.8	17.3	17.3	16.1	4.1	4.2	4	4.1	4.8	6
Hillsboro South	21.9	17.3	17.4	16.0	4.3	4.6	5	4.1	4.3	5
Galchutt	18.8	17.0	17.2	14.5	1.5	1.7	2	3.9	4.2	6
Wahpeton 1	18.7	17.2	17.4	15.6	2.1	2.1	3	4.7	4.7	6
Wahpeton 2	20.3	17.0	17.3	14.5	2.7	2.7	2	5.0	4.9	7
Foxhome	18.8	17.7	17.8	15.5	2.7	2.8	3	5.5	4.8	6
Peet	19.3	17.0	17.2	18.6	2.2	2.0	2	4.8	4.53	6
Mean	20.8	17.0	17.1	15.3	3.0	3.0	3.2	4.4	4.3	5.9

+ 1 = as delivered by grower
2 = crown removed to lowest leaf scar

Table 2. Correlations among several parameters measured on sugarbeet samples obtained at 18 piler locations in the Red River Valley of North Dakota and Minnesota.

		Sucrose		Nitrate		Conductivity		Percent
		1+	2	1	2	1	2	Crown
Sucrose	1	1.00++	.61**	-.37**	-.20**	-.15*	-.08	-.24**
	2		1.00	-.25**	-.43**	-.07	-.27**	-.24**
Nitrate	1			1.00	.55**	.27**	.19**	.29**
	2				1.00	.11	.36**	.28**
Conductivity	1					1.00	.32**	-.07
	2						1.00	-.09

+ 1 = as delivered by grower
2 = crown removed to lowest leaf scar
* = .05 significance level
** = .01 significance level
++ n = 270

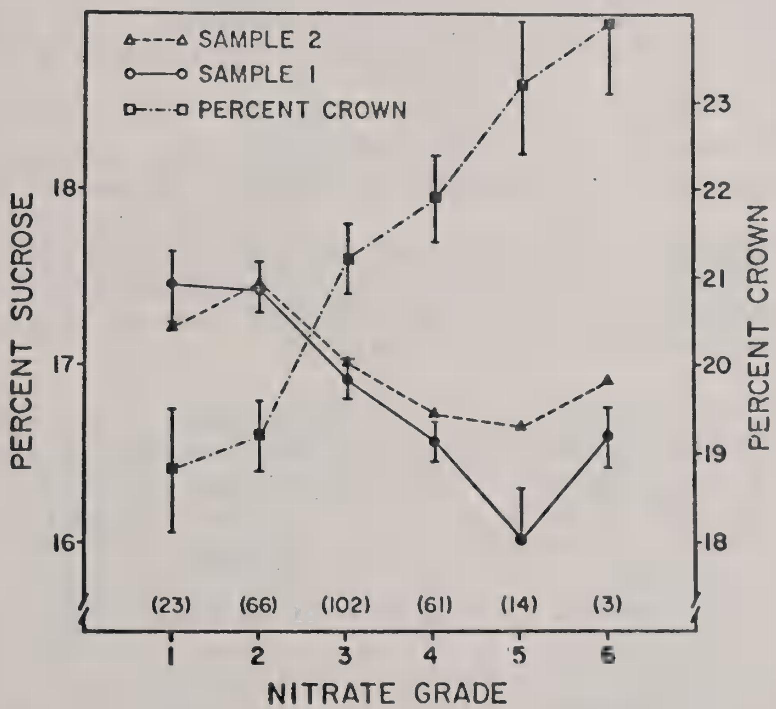

Fig. 4. Effect of nitrate grade on sucrose and percent crown of sugarbeet roots. Data averaged over nitrate levels of sample 1 as delivered by the grower.

Estimation of Percent Crown

An estimate of the amount of crown material removed by the grower when sugarbeets are scalped was reported in the 1975 Sugarbeet Research and Extension Report. This estimate was made by manually harvesting sugarbeet roots that were scalped by the grower and comparing the remaining amount of crown material with the amount of crown material on roots that had not been scalped by the grower. A limited number of samples was made due to the labor and time requirement of this method. A reliable and rapid method would be desirable so a grower or fieldman could estimate the amount of crown material removed when the roots are scalped.

Sugarbeet roots were obtained from three separate experiments over a two-year period. In 1975, roots were obtained for 6 varieties grown at Fargo in a variety test. In 1976, roots were obtained from 5 treatments of a long-term nitrogen experiment at Sidney, Montana. Also in 1976, roots from 8 varieties were obtained from strip-plots located in a commercial field near Kindred, North Dakota.

The leaves and petioles were removed by hand trimming the roots from the nitrogen experiment and with a commercial rotobeater on the variety plots both years. The roots were manually harvested, washed, and weighed. Three horizontal cuts through the crown was made so that the cut surface of the crown was approximately equal to 25, 51, and 76 mm (1, 2, and 3 in.). The fourth cut was made at the lowest leaf scar. The diameter (nearest mm) of each cut surface was determined at a right angle to the lateral root axis. The weight of each segment of the crown was determined. A total of 887 roots were used in these tests.

Regression analysis was used to develop a prediction equation to estimate the amount of crown removed by measuring the diameter of the cut surface.

The regression analysis indicated that the equation was affected by nitrogen level and variety. However, for the equation to be of partical value, since the user may be unfamilar with either the nitrogen level or variety, all experiments were combined into a single analysis.

The regression analysis indicated that the largest R^2 was obtained with a multiple regression formula which consisted of the diameter, diameter squared, and the logarithm of the diameter. Percent crown was converted to a logarithm for analysis purposes. The formula to estimate percent grown is: $\log P = -.0176 + .06527\,(\text{dia}) - .000268\,(\text{dia})^2 - .932\,(\log \text{dia})$.

The amount of crown removed by cuts of various diameter is shown in Table 3. The data indicates that approximately 10% of the crown would be removed with a 51 mm (2 in.) cut. However, this is probably a larger cut than is normally made by the grower. The data reported in 1975 indicated the grower was removing approximately 4% of the crown which would indicate a diameter of 38 mm (1½ in.) To remove 50% of the crown the diameter of the cut would have to be near 80 mm (over 3 in.).

Table 3. **Estimate of percent crown removed by measuring diameter of the cut perpidincular to lateral root axis. Estimates were developed by regression analysis of date from three experiments over 2 years (2 variety and 1 nitrogen).**

Diameter mm	Crown %	Diameter mm	Crown %	Diameter mm	Crown %
21	1.0	51*	10.6	81	54.1
22	1.1	52	11.3	82	56.2
23	1.2	53	12.1	83	58.4
24	1.3	54	12.9	84	60.5
25*	1.4	55	13.8	85	62.7
26	1.5	56	14.7	86	64.8
27	1.6	57	15.7	87	67.0
28	1.8	58	16.7	88	69.2
29	1.9	59	17.8	89	71.3
30	2.1	60	18.9	90	73.5
31	2.3	61	20.1	91	75.6
32	2.5	62	21.4	92	77.7
33	2.7	63	22.6	93	79.7
34	2.9	64	24.0	94	81.7
35	3.2	65	25.4	95	83.7
36	3.4	66	26.8	96	85.6
37	3.7	67	28.3	97	87.5
38	4.0	68	29.8	98	89.3
39	4.3	69	31.4	99	91.0
40	4.7	70	33.1	100	92.7
41	5.1	71	34.8	101	94.3
42	5.5	72	36.5	102*	95.8
43	5.9	73	38.3	103	97.2
44	6.4	74	40.2	104	98.6
45	6.9	75	42.1	105	99.8
46	7.4	76*	44.0	106	100.9
47	8.0	77	45.9	107	102.0
48	8.5	78	47.9	108	102.9
49	9.2	79	50.0	109	103.7
50	9.8	80	52.0	110	104.4

* 25 ≃ 1 inch, 51 ≃ 2 inches, 76 ≃ 3 inches, 102 ≃ 4 inches

A question can be asked that if the grower is only removing 4% of the crown with a cut of 38 mm (1 1/2 in.), is it beneficial to remove only a fraction of the crown and increase the amount of rot and respiration losses in storage? Our data obtained in 1975 and 1976 indicated that all of the crown material delivered to the factory had only a small effect on sucrose, nitrate and conductivity grades. Therefore, would an additional 4% of crown material affect these parameters significantly?

Results of our research and other public and private researches indicate that storage losses can be reduced by not cutting the crown which increases both respiratory and rot losses in the storage piles. Also, our data indicates that only a slight increase in total tonnage would be experienced and this tonnage would not greatly affect quality.

Leaf-Area Investigations

The Sugarbeet Research and Education Board of Minnesota and North Dakota provided a $9,000 grant toward the purchase of a leaf-area meter. Additional funds were provided by the Agricultural Research Service of USDA and by other grants to NDSU. The Research Education Board grant was made to the Department of Plant Pathology at NDSU. The Plant Pathology Department purchased the main component of the leaf-area meter and the Agricultural Research Service purchased the accessory calculation module, for a combined total purchase price of $12,632. The equipment was received August 20, 1976, and is housed in the Sugarbeet Research Center on the NDSU campus. The main component is carried on the NDSU Plant Pathology equipment inventory, and the calculation module is on the sugarbeet project, ARS, USDA, equipment inventory.

The area meter was used to measure leaves obtained at three locations of the 1976 coded variety test. Three leaf ages were selected by position of the leaves in the leaf canopy. Newly developed leaves were selected from the center of the leaf whorl, expanded leaves were selected from the middle or upper part of the canopy, and older leaves were selected from the lower portion of the canopy. Leaves within leaf ages were selected at random from 15 plants in each of the two center rows of each 4-row plot. Nineteen varieties were sampled. The total number of leaves collected was 5,130.

The leaves were collected during the week of Sept. 13, 1976, placed in plastic bags, and transported to the NDSU campus and placed into a cold room at 40 F. Length, width, area, and dry weight (24 hrs. at 80 C) of each leaf was determined. Specific leaf weight (SLW) was determined as the ratio between dry weight and leaf area.

The three locations selected (St. Thomas, Ada, and Breckenridge) represented a range in rainfall during the growing season. The objective of the study was to determine the effect of location and variety on leaf size and density.

All parameters measured was significantly affected by location and leaf age (Table 4).

No significant differences were detected between varieties except for leaf length and none of the leaf-age X variety interactions were significant.

Table 4. Summary of analysis of variance for sugarbeet leaves.

Parameter	Source of Variation: Location	Variety	Leaf Age	Leaf Age X Variety
Length	**	**	**	NS
Width	**	NS	**	NS
Area	**	NS	**	NS
Dry Weight	**	NS	**	NS
SLW	**	NS	**	NS
Len X Wid	**	NS	**	NS

NS = Not significant
** = .01 significance level

The largest leaves were observed at St. Thomas where rainfall was near normal and the smallest leaves were at Breckenridge where rainfall was less than normal. Leaves were both shorter and narrower at the drier locations, (Table 5).

Table 5. Effect of location and leaf-age on several leaf parameters.

	Length mm	Width mm	Area cm^2	Dry Weight g	SLW mg cm^{-2}
Location					
St. Thomas	194	118	181	1.14	5.73
Ada	146	98	116	0.87	7.12
Breckenridge	138	90	104	1.18	10.45
Leaf Age					
Young	93	56	37	0.22	6.46
Mature	160	100	114	0.84	7.94
Old	224	149	251	2.14	8.89

Specific leaf weight was increased by 82% at the drier location compared to the near normal rainfall location. The SLW of the oldest leaves was 38% higher than the youngest leaves. This data supports our previous findings in that leaf parameters is relatively unaffected by varieties. Time of leaf initation and environmental influences substantially determine leaf size and SLW.

SUGARBEET RESEARCH

1976 Report

Section E

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Farmers and Manufacturers Beet Sugar Association
American Crystal Sugar Company
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Buckeye Sugars, Inc.
Michigan Sugar Company
Monitor Sugar Division
Michigan Agricultural Experiment Station

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CONTENTS

Evaluation of Sugarbeet Hybrids

G. J. Hogaboam

The evaluation program in 1976 was cooperative with the Farmers & Manufacturers Beet Sugar Association and its member companies.

The sugar and purity analyses were conducted by M. G. Frakes, Director of Research, Michigan Sugar Company. The percent sucrose, percent clear juice purity, and recoverable white sugar per ton were determined according to "A rapid and practical method of determining extractable white sugar, as may be applied to the evaluation of agronomic practices and grower deliveries in the sugarbeet industry", by S. T. Dexter, M. G. Frakes, and F. W. Snyder, as published in the Journal of the American Society of Sugar Beet Technologists, Vol. 14, No. 5.

Eighteen hybrids, US H20 (as 2 entries), and US H21 were included in a test at the Hayward Farm, at Bay City, MI. These results are reported as experiment 6015302.

Five multigerm pollinators from our Rhizoctonia resistance breeding program were used as pollinators on the same female line as is used to make US H20. The yield and quality of these hybrids were compared with US H20 in five latin square tests in Michigan and Ohio. The pollinator with the most selections for Rhizoctonia resistance produced a hybrid with significantly less pounds of recoverable sugar per acre than US H20. This same hybrid was significantly down in yield of roots and in stand. It appears its problem was seed vigor, since disease was not a significant factor in any of the tests. All other hybrids were not significantly different from US H20 in pounds of recoverable sugar per acre or tons of roots per acre. Three of the hybrids exceeded US H20 in percent sucrose and pounds of recoverable white sugar per ton. Unfortunately, the Rhizoctonia resistance test of these hybrids was a failure this year.

Experiment 6015302 .... 1976 Nursery Hybrids Trial, Hayward Farm, Bay City, Michigan

		PERFORMANCE IN PERCENT OF GENERAL MEAN (GM)					ACTUAL
Source Code	Seed Number	RWS/A	Tons/A	RWS/T	% Sucrose	% CJP	Beets /100'
10053	UI11866 X UI12166 X SP6322-0 (US H20)	112.47	109.53	103.08	102.24	100.50	98.6
10053	UI11866 X UI12166 X SP6322-0 (US H20)	108.66	106.00	102.07	101.13	100.49	97.5
15568	SP74572-03 X SP6822-0	105.35	111.71	94.54--	95.50--	99.64--	83.9
15567	SP74574-01 X SP6822-0	102.49	105.95	96.90--	97.32--	99.80-	94.4
47501	UI11866 X UI12166 X SP7322-0	101.70	101.76	100.62	100.26	100.10	80.0
47502	EL31C2 X SP6121-0 X SP7322-0	101.52	101.50	99.69	99.75	99.89-	81.7
15572	EL31C2 X SP6121-0 X SP6822-0	101.27	104.96	96.54--	96.73--	99.96	87.8
15561	SP71550-01 X SP74570-0 X SP6822-0	101.13	100.18	100.77	100.04	100.37	97.2
15563	SP74564-01 X SP6822-0	101.01	103.22	97.57--	98.31-	99.54--	83.6
15580	SP70682-01 X SP71550-0 X SP6822-0	99.41	98.25	101.05	100.74	100.11	87.8
15565	SP74566-01 X SP6822-0	99.14-	105.01	94.35--	95.64--	99.28--	84.4
15566	SP74571-02 X SP6822-0	97.90-	100.60	97.55--	97.87--	99.93	86.9
15564	SP74565-01 X SP6822-0	96.33-	99.37	96.80--	97.17--	99.78-	81.7
12106	SP71550-01 X SP6822-0 (US H21)	95.94-	96.85-	99.14	99.02	100.00	83.3
15569	SP74513-01 X SP6822-0	95.50--	92.67--	103.07	102.00	100.54	72.5
15578	SP69523-01 X SP71550-0 X SP6822-0	91.87--	93.14--	98.68-	98.87-	99.80-	78.9
47504	SP70527-01 X SP7042-0 X SP7322-0	91.26--	93.02--	98.68-	99.38	99.57--	69.4
15579	SP69588-01 X SP71550-0 X SP6822-0	90.05--	89.61--	99.73	99.39	100.22	80.3
47506	SP71550-01 X SP74570-0 X SP7322-0	89.49--	89.92--	99.21	99.32	99.98	75.8
47505	SP69513-01 X SP69550-0 X SP7322-0	87.47--	86.78--	101.12	101.09	100.08	69.7
47508	SP71550-01 X SP6922-0 (SMOOTH R)	80.27--	82.47--	97.97-	98.09--	99.86-	57.2
	General Mean (GM)	7648#	22.65	337.7#	19.68	94.94	82.0
	LSD 5% as % of GM	11.33	10.67	3.57	2.74	0.61	
	Coefficient of Variation %	9.81	9.24	3.09	2.37	0.52	

- = Significantly under performance of average of US H20 at 5% level.

-- = Significantly under performance of average of US H20 at 1% level.

Rhizoctonia Resistant Hybrids Performance at 5 Locations

Performance in Percent of General Mean

Seed Number 1/	1 2/	2	4	5	3	Five Experiments Total	Average	
	Recoverable White Sugar Per Acre							
75B12x012	102.7	97.1	98.5	102.5	94.1	494.9	99.0	
75B13x024	86.5	92.8	88.6	92.9	89.6	450.4	90.1	--3/
75B18x03	100.3	94.1	106.8	101.0	114.9	517.1	103.4	
76B2x02	103.3	103.6	97.7	93.5	101.8	499.9	100.0	
76B3x02	107.4	105.1	102.1	98.0	102.9	515.5	103.1	
USH20	99.7	107.2	106.3	112.1	96.7	522.0	104.4	
L.S.D. 5%	NS	NS	NS	NS	NS		7.3	
General Mean	6478	6920	6648	5800	4388			
	Tons of Roots Per Acre							
75B12x012	102.1	97.3	98.5	100.4	92.6	490.9	98.2	
75B13x024	86.2	91.7	86.2	91.8	90.7	446.6	89.3	--
75B18x03	99.3	95.1	108.6	103.1	117.0	523.1	104.6	
76B2x02	102.1	105.0	98.9	94.2	109.7	509.9	102.0	
76B3x02	107.0	103.6	99.7	98.0	99.7	508.0	101.6	
USH20	103.2	107.2	108.1	112.5	97.1	528.1	105.6	
L.S.D. 5%	NS	NS	13.1	NS	NS		7.8	
General Mean	22.56	23.91	23.25	18.50	14.75			
	Recoverable White Sugar Per Ton							
75B12x012	100.7	99.9	99.8	102.0	101.3	503.7	100.7	+
75B13x024	100.7	101.3	102.6	101.6	99.3	505.5	101.1	+
75B18x03	100.5	98.7	98.1	97.9	97.7	492.9	98.6	
76B2x02	100.8	98.8	98.9	99.2	98.9	496.6	99.3	
76B3x02	100.4	101.4	102.2	99.7	103.0	506.7	101.3	++
USH20	96.9	99.9	98.4	99.5	99.7	494.4	98.9	
L.S.D. 5%	NS	NS	NS	2.5	NS		1.6	
General Mean	286.4	289.3	285.8	314.3	297.9			
	Percent Sucrose							
75B12x012	100.2	100.2	100.3	101.6	101.3	503.6	100.7	+
75B13x024	100.3	101.0	102.0	101.0	99.9	504.2	100.8	+
75B18x03	100.7	99.0	98.7	98.6	97.8	494.8	99.0	
76B2x02	101.2	98.5	99.2	99.6	99.0	497.5	99.5	
76B3x02	100.1	100.9	101.7	99.8	102.2	504.7	100.9	+
USH20	97.5	100.3	98.0	99.3	99.7	494.8	99.0	
L.S.D. 5%	NS	NS	NS	1.9	NS		1.4	
General Mean	16.53	17.08	16.79	18.46	17.59			

(Footnotes next page)

(continued)

Performance in Percent of General Mean

Percent Clear Juice Purity

Seed Number[1]	1[2]	2	4	5	3	Five Experiments Total	Five Experiments Average
75B12x012	100.3	99.8	99.7	100.2	100.0	500.0	100.0
75B13x024	100.2	100.1	100.3	100.3	99.7	500.6	100.1
75B18x03	99.9	99.9	99.7	99.7	100.0	499.2	99.8
76B2x02	99.7	100.2	99.8	99.8	100.0	499.5	99.9
76B3x02	100.2	100.3	100.2	99.9	100.4	501.0	100.2
USH20	99.7	99.8	100.3	100.2	100.0	500.0	100.0
L.S.D. 5%	NS	NS	NS	NS	NS		NS
General Mean	95.28	94.58	94.88	94.63	94.49		

Beets Per 100' of Row

Seed Number	1	2	4	5	3	Total	Average
75B12x012	98.1	101.2	100.8	93.7 -	103.0	496.8	99.4
75B13x024	88.3 -	83.8	79.9 -	91.0 -	65.4 -	408.4	81.7 -
75B18x03	100.0	98.0	108.5	110.3	109.1	525.9	105.2
76B2x02	92.6	105.0	99.6	88.8 -	103.0	489.0	97.8
76B3x02	117.2	113.4	110.4	98.5 -	115.2	554.7	110.9
USH20	103.7	98.6	100.8	117.8	104.2	525.1	105.0
L.S.D. 5%	14.1	16.1	14.9	17.1	20.5		9.4
General Mean	89.7	86.2	87.6	79.8	85.9		

1/ All hybrids had the same female parent (UI1866 x UI2166);
All pollinators (except USH20) were from the cross (FC702/2 & /4 x SP6822-0);
75B12x012 pollinator roots were F_3 roots from 2 synthetics of F_2 roots with 3-EL Rhizoctonia selections.
75B13x024 pollinator roots were BC_1, F_2, with 4-EL Rhizoctonia selections.
75B18x03 " " " BC_2 (SP6822-0 is recurrent parent) with 3-EL Rhizoctonia selections.
76B2x02 pollinator roots were BC_1, F_2 (EL43) with 3-EL Rhizoctonia selections.
76B3x02 pollinator roots were synthetic of superior F_2 roots (EL42) with 2-EL Rhizoctonia selections.

2/ 1=Russell Bros. Farm, Leipsic, Ohio, 1 row plots 30' long. Planted 4/8/76, harvested 10/11/76 = 186 days in ground.
2=Schroeder Farm, Ottawa, Ohio, 1 row plots 30' long. Planted 4/9/76, harvested 10/5/76 = 179 days in ground.
4=Schroeder Farm, Ottawa, Ohio, 1 row plots 30' long. Planted 4/9/76, harvested 10/5/76 = 179 days in ground.
5=Bean & Beet Research Farm, Saginaw, Michigan, 1 row plots 39.4' (12 meters) long. Planted 4/14/76, harvested 9/20/76 = 159 days in ground.
3=Bean & Beet Research Farm, Saginaw, Michigan, 3 row plots 16.4' (5 meters) long. Planted 5/13/76, harvested 9/22/76 = 132 days in ground.

3/ Significant deviations from USH20 performance.

Sugarbeet Disease Investigations in 1976[1/]

C. L. Schneider

1. Blackroot disease (Aphanomyces cochlioides)

A. Evaluation of blackroot resistance - A test of 99 breeding lines was conducted in the greenhouse. Plants were grown in 10.2 cm pots of autoclaved potting mix to which oospore inoculum (approximately 30 x 10^3 oospores/pot) was added with the seed at planting. There were 6 replicates of each entry. USH20 and Syn. Ck. were included as moderately resistant and highly susceptible check varieties, respectively. Disease severity ratings of each plant were made 30 days after planting, according to an index from 0 (no symptoms) to 5 (dead). The distribution of the mean disease severity ratings of the 99 entries in relation to the USH20 check variety was as follows: Significantly lower (more resistant = 30.3%; same = 62.6%; higher (more susceptible) = 7.1%. The mean ratings of USH20 and Syn. Ck. were 3.5 and 4.2, respectively ($LSD_{.05}$ = 0.5). The mean rating of all entries = 3.1, and the C.V. of the test = 13.22%.

2. Crown rot disease (Rhizoctonia solani)

A. Evaluation of crown rot resistance - A test of 132 breeding lines was conducted in the East Lansing crown rot nursery. Plots were 5 m long and replicated 3 times. On 12 July, dry barley grain inoculum of R. solani was dispensed into the plant row at the rate of 19 cc/m with a tractor-mounted modified granule applicator. On 24 September, plots were rated according to crown root incidence and severity, expressed as percent. The mean rating of USH20 check variety in four experiments = 65.6%, and USH21 check = 74.8%. Ratings of the entries ranged from 36.4% to 80.8%. There were 28 entries with disease ratings significantly below (more resistant than) those of the check varieties. Roots of superior entries were selected as sources of Rhizoctonia resistance in the breeding program.

B. Evaluation of fungicides for crown rot control - Field plots of variety USH20, 5 m long, were side-dressed with sorghum grain inoculum of R. solani. Fungicide treatments were applied with a hand-operated, CO_2-powered sprayer in 561 liters water/ha. The following four treatments were applied on the soil surface in a 20-cm band immediately after planting: carboxin + thiram, .38 + .38 kg (active ingredient/ha); carboxin, 1.68 kg; potassium N-hydroxymethyl-N-methyldithiocarbamate, 14.7 kg; triadimefon, 2.62 kg. The following 14 treatments were applied along the rows and into the crowns on 29 June and 22 July: PCNB, 2.24 + 4.48 kg; fentin hydroxide, .33 kg; potassium N-hydroxymethyl-N-methyldithiocarbamate, 4.90 kg; benodanil, 0.50 and 1.00 kg; triadimefon, .56 and 1.12 kg; chlorothalonil, 1.68, 3.36, 6.72 kg; benomyl, .42 and .56 kg; carboxin, 1.68 kg; carboxin + thiram, .38 + .38 kg. Disease incidence (no. plants infected/no. plants inoculated) was determined on 20 October.

[1/] Cooperation of the following personnel in various phases of these investigations is acknowledged: D. R. Christenson, Dept. of Crops and Soil Science, Michigan State University; G. J. Hogaboam, Agricultural Research Service, U.S.D.A.; H. S. Potter, Dept. of Botany and Plant Pathology, Michigan State University; R. L. Sims, Agricultural Research Service, U.S.D.A.

All treatments showed significantly less crown rot than the untreated control which = 28.1% (mean of 9 plots). There were no significant differences in disease incidence among the treatments which ranged from 3.1 - 16.9%. Disease level in the chemical control test was considerably lower than in the previously described test of breeding lines because of different inoculation methods employed.

C. Effect of cropping sequence and rotation period on crown rot incidence - A cooperative study with Crops and Soil Science Department, Michigan State University, was conducted at the Saginaw Valley Beet and Bean Research Farm involving 4 cropping systems and 2, 3, and 4-year rotation periods. Data from 1973 to 1976 consistently show significantly less natural infection of crown rot in sugarbeet following corn than following navy beans. Differences among 2, 3, and 4-year rotation periods were not significant.

3. Leafspot disease (*Cercospora beticola*)

A. Evaluation of fungicides for leafspot control - Treatments were tested in plots of variety USH20 inoculated with *C. beticola*. Treatments were applied with a hand-operated CO_2-powered sprayer in 561 liters water/ha. One treatment - triadimefon, 5.24 kg (active ingredient/ha) - was applied to the soil in a band 20-cm wide alongside the plant row on 12 August. Other treatments were applied as foliar sprays applied twice, and included the following: triadimefon, .56 and 1.12 kg (active ingredient/ha); benomyl, .28 kg; benomyl + maneb, .14 + 1.34 kg; benomyl + Cu $(OH)_2$, .14 + 1.34 kg; benomyl + fentin hydroxide, .14 + .17 kg; MBC + maneb, .10 + 1.21 kg, .20 + 2.42 kg; fentin hydroxide, .33 kg; cyclohexamide, 4.4 and 8.8 g; chlorothalonil, 1.26 and 1.68 kg; captafol, 2.24 and 3.36 kg; captan, 4.20 kg; TBZ, .18, .24, .36 kg; flowable sulfur + copper, 3.36 kg + .45 kg. All treatments, except cyclohexamide, reduced leafspot severity significantly below that of the untreated control which, in accordance with a disease index from 0 (no symptoms) to 9 (complete defoliation) = 4.1 (mean of 5 plots). Disease indices of the treatments ranged from 1.4 - 2.7. There were significant differences among treatments with the following providing the highest degree of control: benomyl, alone and in combination with maneb, fentin hydroxide, and $Cu(OH)_2$; MBC; TBZ (.36 kg/ha). Cyclohexamide treatments were extremely phytotoxic.

4. Powdery mildew (*Erysiphe polygoni*)

A. Test of fungicides to control powdery mildew - The first symptoms of a naturally occurring powdery mildew epiphytotic in plots of variety USH20 at East Lansing, Michigan were observed on 23 August. By the latter part of September, disease incidence was 100%. There were three types of fungicide treatments. A soil application of triadimefon (2.62 kg active ingredient /ha) was applied on 2 August followed by a foliar spray (1.12 kg) on 26 August. The following treatments were applied as foliar sprays on 2 and 26 August: triadimefon, 1.12 kg; wettable sulfur + benomyl, 3.85 kg + .27 kg; benomyl, .28 kg + 2.5 ml oil/liter; TBZ, .36 kg + 2.5 ml oil/liter. The following treatments were applied as foliar sprays on 26 August: wettable sulfur + benomyl, 2.68 kg + .20 kg and 3.85 kg + .27 kg; triadimefon, .56 and 1.12 kg; fentin hydroxide, .21 and .33 kg; benomyl, .14 and .28 kg + 2.5 ml oil/liter; TBZ, .21, .28, .42 kg, + 2.5 ml oil/liter; chlorothalonil, 1.26 and 1.68 kg; flowable sulfur, 8.74 kg; wettable sulfur, 8.98 and 10.65 kg; copper + flowable sulfur, 1.26 kg + 1.12 kg and 1.68 kg; cyclohexamide, 2.6 g, 6.9 g, 13.8 g. All treatments were applied with a hand-operated, CO_2-powered sprayer in 561 liters of water/ha. Disease severity ratings were made

on 22 September and 8 October in accordance with an index from 1 (no symptoms) to 9 (extremely severe). Disease intensity did not change significantly between the two reading dates. The disease severity rating of the untreated control = 3.00 (mean of 4 plots). All treatments except fentin hydroxide (.21 kg) and chlorothalonil (1.26 kg) significantly reduced powdery mildew severity. There were no significant differences among the other treatments, with severity ratings ranging from 1.0 - 2.1. Cyclohexamide treatments were phytotoxic.

Abstracts of Papers Published in 1976

1. Schneider, C.L. 1976. Sugarbeet diseases and their control. Sugar Beet Journal 39(2): 11-12.

Blackroot (*Aphanomyces cochlioides*, *Pythium spp.*, *Rhizoctonia solani*); crown rot (*R. solani*); and leaf spot (*Cercospora beticola*) are important diseases threatening sugarbeet production in the Great Lakes area. Use of modified cultural practices and recommended fungicides can be used to reduce likelihood of serious loss by each disease. In addition, sugarbeet varieties resistant to blackroot and leafspot are productive where non-resistant varieties suffer serious loss.

2. Safir, G.R. and C. L. Schneider. 1976. Diffusive resistances of two sugar beet cultivars in relation to their black root disease reaction. Phytopathology 66: 277-280.

Sugarbeet (*Beta vulgaris*) seedlings, four weeks old, were inoculated with zoospores of *Aphanomyces cochlioides* and diffusive resistances to vapor flow were determined at intervals with a diffusion porometer. Two cultivars were used: high susceptible SP63269-0 and less susceptible SP6822-0. Five days after inoculation diffusive resistances of leaves of cultivar SP63269-0 averaged 4.5 sec cm $^{-1}$, whereas resistance of SP6822-0 averaged 2.6 sec cm $^{-1}$. Inoculated plants of SP63269-0 and those from which water was withheld had similar relationships between leaf diffusive resistance and leaf water potential. Whole plant resistances to water transport calculated from steady state transpiration data were 10-fold larger for inoculated than for control plants 9 days after inoculation. The increased diffusive resistance of infected plants appears, therefore, to be caused by decreased water supply to leaves.

BREEDING SUGARBEETS FOR RESISTANCE TO BLACK ROOT AND LEAF SPOT

G. E. Coe

Research work on sugarbeets at the Agricultural Research Center, Beltsville, Maryland, is directed toward varietal improvement of sugarbeets resistant to black root and Cercospora leaf spot, important diseases in eastern United States. Heavy selection pressure for resistance to these diseases has been successful but has resulted in a decline of inherent yield potential. Testing for disease resistance is continuing, but only the lines with the least resistance are being discarded. Selection pressure is now being applied to increase yields while maintaining sucrose content and other desirable characteristics.

Testing for Black Root Resistance

The resistance check variety, SP7134-00, presently being used in the greenhouse black root screening test is much more resistant than US H20 and the resistant check used previous to 1971. Present tests cannot be compared to tests previous to 1971. The 1975 test is compared to the 1973 test in Table 1.

TABLE 1. Results of greenhouse black root testing in 1975 and 1973.

	1975-76 Test		1973-74 Test	
	Number Progenies Tested	Progenies as good or better than SP7134-00 %	Number Progenies Tested	Progenies as good or better than SP7134-00 %
Progenies of M M Selection	234	47.4	343	27.4
M M progenies of smooth-root selections from SP6922-0	80	47.5	None	---
Monogerm progenies	58	34.5	69	43.5

The average amount of resistance of the multigerm breeding lines has probably improved slightly. On the other hand the average amount of resistance in the monogerm lines has not increased, but is perhaps slightly less than the lines tested in 1973. However, except for a few lines all the breeding material is quite good in resistance to black root.

Testing for Leaf Spot Resistance

A good leaf spot epidemic was obtained in the 1976 Beltsville leaf spot nursery. Results of this test are presented in Table 2.

TABLE 2. Results of leaf spot test in 1976 Beltsville leaf spot nursery.

Experiment Number	Description	No. lines Tested	Leaf Spot Ratings* Average lines Tested	US H20	US H21
1 and 11	MM lines from Beltsville	66	2.3	4.2	2.3
4	MM lines from East Lansing	27	1.8	3.8	2.3
5	MM Rhizo. resist. lines from East Lansing	31	2.9	4.5	2.4
2	mm lines from Beltsville	27	1.8	4.3	2.0
3	mm lines from East Lansing	12	2.2	4.3	2.2

*Leaf spot scale 0-10: 0 = No spots; 10 = All leaves dead.

In these experiments US H20 was about the least resistant line in the test. All the breeding lines except the Rhizoctonia selections from East Lansing have a relatively high degree of resistance, and all except a few of the Rhizoctonia resistant lines were better than US H20. The level of leaf spot resistance of the Rhizoctonia resistant lines is lower than the other breeding lines as a result of outcrossing to Rhizoctonia resistant stocks having less leaf spot resistance.

Selections for Resistance to Powdery Mildew

A moderate epidemic of powdery mildew occurred in one Beltsville sugarbeet nursery plot, and a milder epidemic was observed in the leaf spot nursery. Evaluations for resistance to powdery mildew were made in all experiments, but in the leaf spot nursery only the most susceptible lines were significantly different. In the other nursery plot there appeared to be good differences between lines and opportunity for selection within lines. Eighty-five apparently resistant roots were selected from among some 1,100 plants of SP6822-0. These will be increased in the summer of 1977. Powdery mildew resistance ratings for lines in this plot are presented in Table 3.

TABLE 3. Powdery mildew resistance ratings in the 1976 Beltsville nursery test.

Experiment Number	Description of Material	No. of Progenies	Average Powdery Mildew Rating*
23	B_3 - F_4 of sugarbeet x B. corolliflora hybrid	119	2.2
24	F_2 of sugarbeet x B. maritima hybrid	21	3.5
25	2nd cycle selection smooth roots from SP6922-0	46	2.7
	SP6922-0	--	3.0
	US H21	--	3.5
	US H20	--	3.7

*Scale 0-10: 0 = no disease apparent; 10 = leaves very white.

Some progenies stemming from the sugarbeet x B. corolliflora cross appeared to have no disease, and as a group were much more resistant to powdery mildew than any other material in the field. However, there seems to be a lot of variation in resistance among sugarbeets themselves, and it shouldn't be necessary to go to the wild species to obtain resistant genes.

Selecting for Higher Yields

Selection of large individual roots from field plots is not necessarily a selection for better inherent yielding ability. In fact, selections of large roots in a disease testing nursery is almost always a selection for better disease resistance and is unrelated to yielding ability. It would appear that the only way to select for better yields is to grow the plants in an environment that is completely free from all diseases and pests and free from environmental differences, i.e., nutritional differences, temperature differences, differences in light energy received, etc. Snyder, Doney and others have been attempting to do this in the greenhouse and in growth chambers. The methods they are developing appear promising. I first used this technique to make selections in SP6922-0 in 1975. Selections were made on the basis of root weights and root to shoot ratios. The large rooted selections were divided into 2 groups according to root to shoot ratio and crossed to SP75550-01 mm MS. The smaller rooted plants of SP6922-0 were likewise divided into 2 groups. Roots of SP73514-01 mm MS were split, and half of the root put in with one group for pollination. The other half of the root was put in isolation with the other group of pollen fertile plants. Yield comparison of progenies from companion 1/2 roots then is a comparison of the combining ability of the pollinator lines. A preliminary growth chamber test indicates that plants of SP6922-0 selected on the basis of a high root to leaf ratio produced progenies with larger roots than selected plants of SP6922-0 having a relatively low root to leaf ratio. Since all the evidence indicates that the technique is effective in selecting for higher yield potential, we are now using three growth rooms with a capacity of 378 plants every

30 days for making such selections. Thus far, selections have been made in SP6822-0 MM PF, SP6922-0 MM PF, SP74571-0 mm O-type, SP74571-02 mm MS, SP75550-0 mm O-type, and SP75550-01 mm MS. At present, SP76745-0 mm O-type, and SP76745-01 are in the growth rooms for selection.

Selections for "Soil-Free" Roots

Selected conical-shaped roots stemming from crosses with garden beets can be harvested with less adhering soil than selections for smooth "clean" roots directly out of SP6922-0. One line of the former type had about 95% of its roots lifted from the ground relatively free from soil. Many other progenies of this type were also good. Table 4 gives a comparison of these lines with US H20 harvested under the same somewhat difficult wet conditions.

TABLE 4. Agronomic characteristics of soil-free breeding lines compared with US H20 in the 1976 Beltsville nursery.

Characteristic	US H20	Soil-Free Lines
Lbs. soil/ton roots	258 lbs.	35 to 125 lbs.
Root yield/acre	28 1/2 tons	25 to 31 tons
% sucrose	13%	7 to 12%
% Raw Juice Apparent Purity	81.30%	75.00 to 85.93%
Leaf Spot Rating	5	4 to 6
Black Root Resistance	Moderate	Moderate
Powdery Mildew Resistance*	2	0 to 3

*Powdery mildew was not as severe in this test as in our other nursery plot.

From Table 4 it is obvious that the poorest characteristic of the "soil-free" roots from this line of breeding is the low sucrose content. This is being increased only slightly with each backcross, but perhaps the sucrose content of soil-free beets will not have to equal present commercial lines because they have relatively high purity.

The other line of selection for smooth roots (directly from SP6922-0) doesn't have the handicap of poor sucrose content, but the selected plants transfer the smooth root characteristic to their progeny at a much lower frequency than roots stemming from garden beet crosses. Also preliminary indications are that smooth roots selected from SP6922-0 have poorer combining ability than the parent line. Thus it appears that it may be some time before "soil-free" roots are a practical reality.

Discovery of New O-Types

Ten new O-type lines were located in greenhouse indexing tests in 1975-76. These were grown in the nursery in 1976, but the leaf spot epidemic among these transplants was not sufficiently severe to obtain reliable disease evaluations. All should have sufficient resistance for commercial use in the event they are otherwise acceptable in hybrid combinations.